JUNE, 1934

METALS & ALLOYS

The Magazine of Metallurgical Engineering

PRODUCTION · FABRICATION · TREATMENT · APPLICATION

Current Metallurgical Abstracts

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Production • Fabrication • Treatment • Application

PUBLICATION OFFICE:
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CURRENT METALLURGICAL ABSTRACTS

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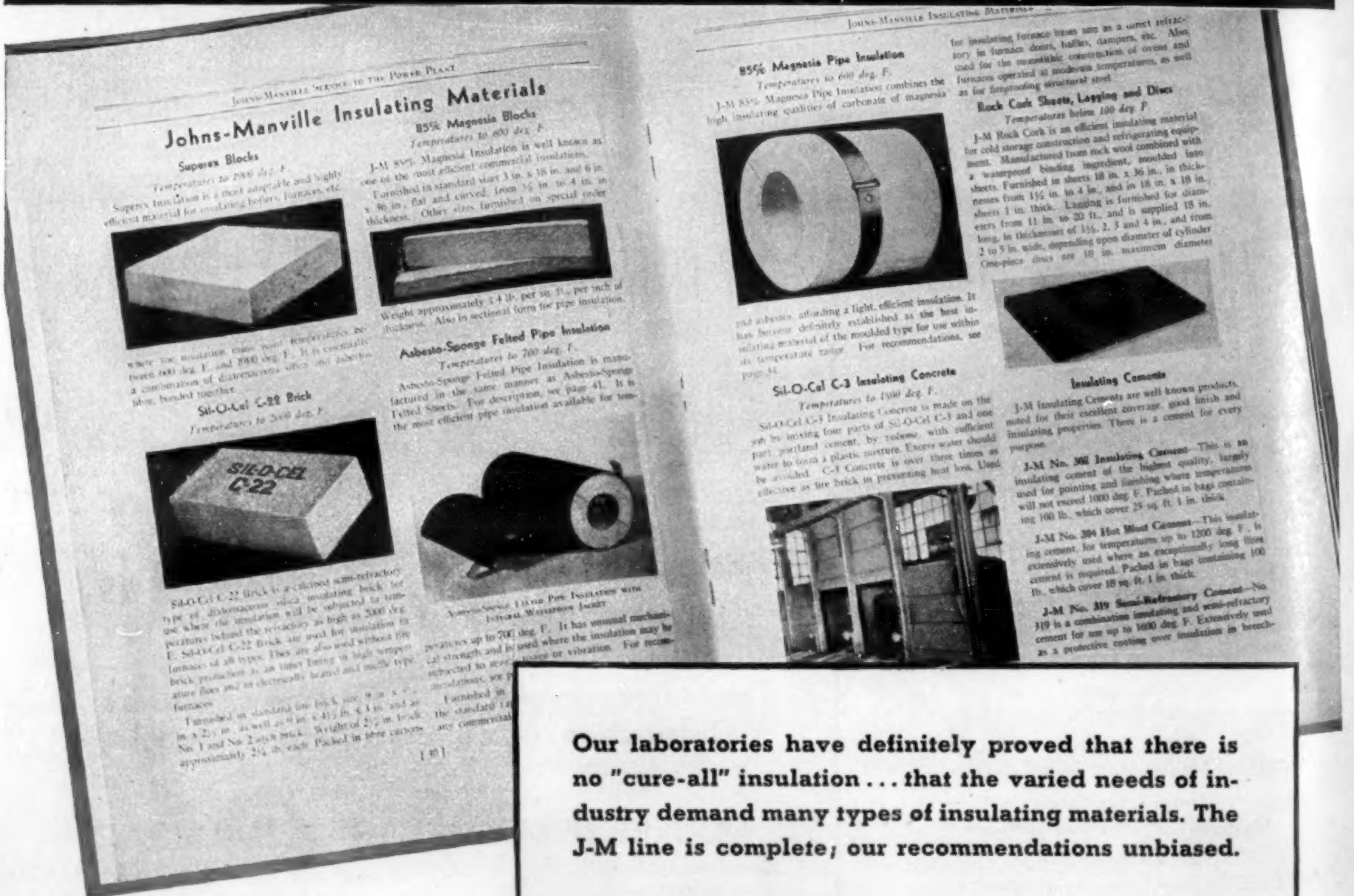

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HIGHLIGHTS

by H. W. GILLETT

Wear of Iron

Wear of cast iron is discussed by Wallachs & Gregor (page MA 292 L 1), Heller (page MA 292 R 2) and Söhnchen & Piwowarsky (page MA 294 L 1). They all agree that pearlitic iron has higher wear resistance than ferritic iron. They recognize the value of alloy cast iron, but, for engine cylinders, Wallachs & Gregor think that hot-poured unalloyed iron shows the best combination of machineability and wear resistance. They, and Heller as well, consider that finely distributed graphite may make an iron show poorer wear resistance than when the graphite is in coarser flakes.

Dodge Huckleberry Patches to Avoid Corrosion

Pipe lines may have to dodge around huckleberry patches. Electrical World (page MA 294 L 1) says huckleberries need acid soil and that the moisture in such soils in high in CO_2 and contains organic acids. These attack ferrous metals.

Air-Conditioning to Prevent Rust

Krais (page MA 294 L 2) says that to prevent rust in the moist air of a textile mill one has only to release enough ammonia to neutralize the CO_2 in the air. One more brand of air-conditioning.

Another Idea for Metal Spraying

Ritter (page MA 296 L 1) reports that metal spraying the interior of a cast iron pump housing with bronze, stopped the attack between the housing and the bronze rotor, which was filling a copper pipe hot water system with rust.

New Edition of Metallurgy of Iron

A new edition of Stoughton's Metallurgy of Iron and Steel (page MA 300 R 1) helps the youngster to learn the things he ought to know, and enables the oldster to check up on his own information and see if he is up to date on modern advances.

Throwing Power of Electroplating Baths

Engelhardt and Schoenfeldt (page MA 272 L 4) give results of tests which permit choosing the distances for plating in practice.

Radium in Engineering Practice

X-rays for inspecting metal products are well established but due to the greater thicknesses which can be examined with radium, the article by Pullin (page MA 274 R 10) will be of interest.

DO YOU want to know what metallurgical engineers are saying, the world over? Look in the Current Metallurgical Abstracts. Here are some of the points covered by authors whose articles are abstracted in this issue.

Industrialized Russia

There have been many books written on Russia in recent years but the one by Alcan Hirsch (page MA 301 R 1) is the first written by a man who has had opportunities for observation, especially in the chemical industries and its allied industry—the metallurgical industry.

Granulating Blast Furnace Slag

Kroupa (page MA 247 R 1) considers an English method of granulating blast furnace slag that saves the drying of the slag worth bringing to the attention of German operators.

Casting Brass Ingots

Genders and Bailey (page MA 250 R 4) summarize 14 years' work on ingots for 70/30 brass strip. Introduction of 0.05% P is said to improve the surface greatly without injuring the properties.

Listen to the Surface Finish

Surface finish as of a ground surface according to Franke (page MA 271 L 5) can be evaluated by an acoustic method, something like running a phonograph needle over the surface as if it were a record, and listening to the pitch of the note produced.

Gear Wear

Gear wear, according to Fink & Hofmann (page MA 292 R 1) is due to oxidation of surfaces made active by squeezing out foreign materials at the surface and baring clean metal. Colloidal graphite is suggested for gear lubricants, since it's hard to squeeze out. But Ulrich (page MA 294 R 1) says rusting has nothing to do with pitting of gears, for pits form at fine cracks due to repeated stress at contact points. Hence case hardening or cyaniding is suggested to strengthen the surface.

Cumulative Index to the Current Metallurgical Abstracts

If true worth is determined by usefulness, the abstracts which appeared during 1932 and 1933 will unquestionably take on a new value with the appearance of the Cumulative Index for these years. The experience gained by the editorial staff in compiling the index for 1929-1931 will contribute toward making this issue of the Cumulative Index a comprehensive and serviceable work, an indispensable tool and a valuable aid to every engineer concerned with the production, fabrication, treatment and application of metals and alloys.

The index is comprised of two parts: 1. a complete subject index and 2. an author index. (see page MA 270)

Place your order for the index immediately, only a limited number will be printed.

Books

It is interesting to note the number of books reviewed in this issue: The Casting of Aluminum (page MA 250 R 2); The Casting of Brass Ingots (page MA 250 R 4); Technology of Alloy Steels (page MA 251 R 7); Handbook for Purchase and Acceptance of Metals and Alloys (page MA 275 L 8); Non-Ferrous Metals, Materials Handbook (page MA 283 L 3); Handbook of Inorganic Chemistry (page MA 285 R 1); Tool Steels (page MA 285 R 2); S.A.E. Handbook (page MA 300 R 6); Review of Science (page MA 300 R 8); Metallurgy of Iron and Steel (page MA 300 R 1); Industrialized Russia (page MA 301 R 1) and The Mineral Industry, Its Statistics, Technology and Trade During 1932 (page MA 301 R 3).

Testing Drawing Properties of Rolled Zinc

Kelton and Edmunds (page MA 254 R 5) find that mechanical tests do not indicate the drawing properties of zinc and zinc alloy sheets.

Quenching and Internal Stresses

Bühler and Scheil (page MA 258 R 2) find that in steels containing 9 to 23% nickel, lowering the temperature of the quenching bath to the temperature range of martensite formation, caused the influence of this transformation on the formation of internal stresses to increase.

Electroplating

A cyanide-free copper bath for electroplating on steel is disclosed by Fink and Wong (page MA 271 R 9).

EDITORIAL COMMENT

Coöperative Research

COÖPERATIVE research should be laid out so that it will be the basis for further private work and also to encourage rather than appear to stifle or discourage private initiative. For this reason it should deal only with the study of fundamentals that are of concern to a certain group who are willing to pool their interests to attain the information desired. The results of work done in this way should be not only of value in respect to the data collected, but stimulating to all of those connected with the work.

To be attractive, coöperative research should be more economical of time and money than individual work on the same subject. Two methods of organization have been employed. Special problems concerning a particular industry are sometimes studied by groups of investigators representing that industry, or the industry may become associated with others interested in the same problem. For instance, the American Society of Refrigerating Engineers and the American Petroleum Institute have done notable work on their own internal problems. The latter have handled the refinery problems within the industry but have associated themselves with the Bureau of Standards and the American Gas Association for the study of pipe line corrosion and coating problems. Similarly, several of the leading American iron and steel manufacturers have closely coöperated with committees of the American Society for Testing Materials and with consumers, but this industry as a whole has no organization of its own for doing this work, such as the Committee on Corrosion sponsored by the Iron and Steel Institute and the Iron and Steel Manufacturers of Great Britain. It is well known that investigations of the relative corrosion of commonly-used types of ferrous and non-ferrous metals and protective coatings have been carried on extensively for many years by the American Society for Testing Materials' committees which include representatives of both producers and consumers. About $30,000 in each have been spent on this work, but this does not include the large amount of time and material also contributed by various coöperating interests.

The world-wide group of problems that are commonly included under the term "Corrosion" offers many subjects suitable for coöperative work. There is, however, no general coördination of practical or scientific work on these problems. The present system is producing results with probably the least amount of organization, but it seems desirable that there should be a national group representing those who are engaged in the special industrial phases of this work to encourage and sponsor scientific research on fundamental problems related to corrosion. These problems should be defined and assigned, with adequate financial support, to the men who are best able to carry on the work. The nearest approach to such organized effort that we have at present is the association of the oil and gas interests and pipe manufacturers with the U. S. Bureau of Standards on soil corrosion, previously referred to. It would seem that the national societies should lend their influence and endeavor to secure more general support and better coördination of scientific work on this problem.

In Europe, an International Mixed Committee was organized several years ago, including representatives of water, gas, and underground electrical communication interests, and is reported to be doing effective work on matters pertaining to electrolysis and corrosion of underground pipe and cables. In America, similar groups have been organized in a few localities. Evidently the public utilities recognize the importance of this problem and the need for coöperative action.

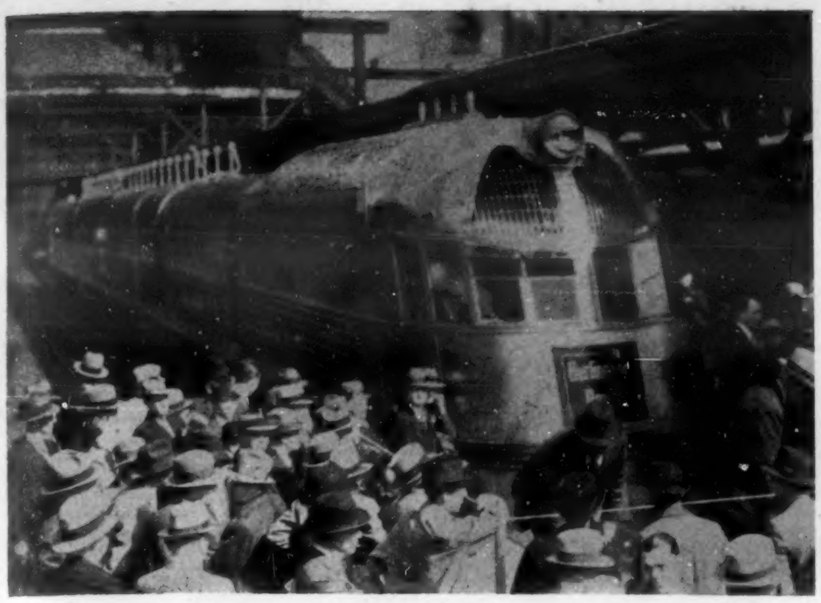
Last September at an International Conference on Corrosion held in Chicago, under the auspices of the Electrochemical Society, a considerable amount of overlapping and duplication of research work was apparent. The suggestion was made by one of the foreign contributors that a plan for international coöperation on some of these problems might be developed to advantage.

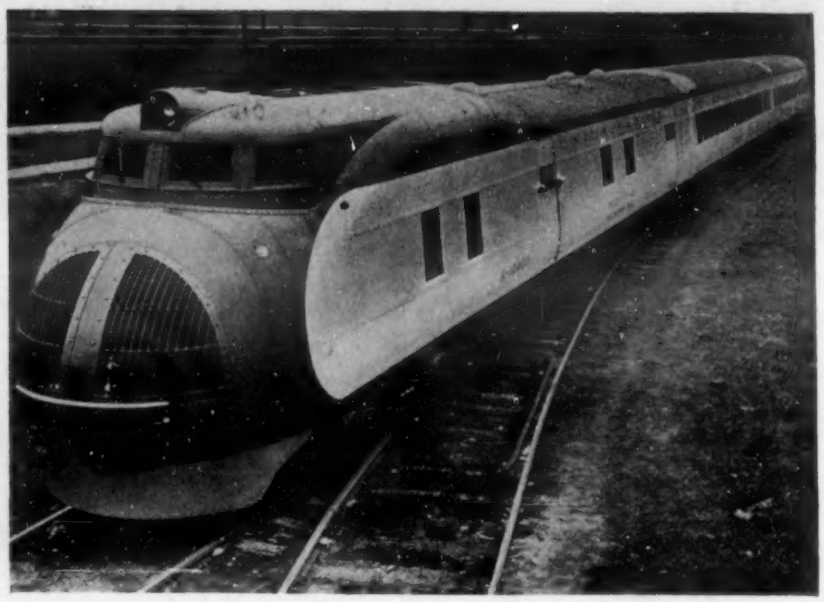
No figures are available as to the total amount of money and time now being spent on corrosion problems in general, but it must be a very considerable sum. However, a relatively small part has been devoted to the scientific study of corrosion in this country. Evidently much more remains to be done and, as in research that affects public health, the results are of such general and practical use to all that we should do our share in the study of the fundamentals in order that corrosion prevention will be put on a sound scientific basis as soon as possible.* This is a problem to which the Federal Government could consistently contribute financial support.

Problems suitable for coöperative work should be (1) of fundamental interest to an industry or a large group of the industries and consumers. (2) They should be without apparent competitive features on which members of the coöperating group have already done a substantial amount of work. If individuals have worked on the problem they should feel morally bound to turn over the complete results to those in charge without keeping any cards up their sleeves. (3) When the objective has been reached, before competition is likely to creep in, coöperative work on the specific problems involved should be brought to a close, leaving further development and the practical application of results to individual initiative. Embarrassing situations are invited by continuing to work out details coöperatively which can be just as

(Continued on Page 117)

*F. N. Speller. The Corrosion Problem With Respect to Iron and Steel (*Howe Memorial Address*). *Metals Technology*, Technical Publication 553, 21 pages.





ECONOMIC RESULTS of METALLURGY*

Recent and to Come

by Samuel L. Hoyt**

In a discussion of recent metallurgical history it seems advantageous to divide the field into two classes—creative work which brings out new things or new concepts, and developmental work which extends the uses of known materials and processes. Amongst the results of the former may be noted a large group of alloy steels including tool and die steels, new nickel, copper, aluminum and zinc alloys, the age-hardenable alloys, the new corrosion—and heat resistant alloys, and a number of semi-rare metals which have recently become available, such as tungsten, molybdenum, tantalum, beryllium, etc.

In the automobile industry we have an illuminating example of the part which metallurgy may play in the national economy. It is the automobile steels, the high speed tool steels, and the heat treatment thereof that makes the modern car possible, along, naturally, with other factors. With the automobile came employment for thousands in the manufacture and sale of automotive products, and in construction work and the transportation industries, to say nothing of the recreational, social, and business advantages which accrue to the large-scale ownership of our "pleasure cars." All of this could hardly have happened were it not for the cutting efficiency afforded by the high-speed tool steels of Taylor and White, for were we obliged to perform all machining operations at speeds commensurate with the cutting efficiency of the simple carbon steels, the cost of the automobile would rise to prohibitive values.

The important stainless steels furnish material for the chemical and food industries, hardware, etc., and amongst their chief rivals are the somewhat similar nickel alloys with copper or with chromium. If the benefits derived from all individual installations of these corrosion-resistant alloys could somehow be integrated, we would find that they amount to a sizeable economic factor. In a similar way, the heat-resistant alloys based on iron, nickel and chromium become important parts of equipment which must operate at high temperatures, and as electrical resistance elements, they make it possible to have the industrial electric furnace and many useful household appliances. The same sort of story could be told about many non-ferrous alloys, which there is not space to mention specifically except to say that individually and collectively they result from research work which is not surpassed in quality. That the groups producing such alloys recognize that advances in their businesses are dependent on research and hence heartily support research, is itself an economic factor of no slight importance.

A development deserving particular mention is that which brought one of the less common elements of the Peridoic System into daily use, and also introduced a new branch of metallurgy. This element is tungsten and the new branch is the so-called "powder metallurgy." While the valuable properties of tungsten as a lamp filament had been recognized, there remained the problem of producing it in usable wire form. This was accomplished by the well-known Coolidge process for making a ductile wire out of the refractory tungsten metal powder without going through the usual melting process. This was an achievement of the highest order. Dr. Jeffries is authority for the estimate that the intrinsic value of the tungsten filament in giving better and cheaper light is $300,000 per pound. The radio tube is also indebted to powder metallurgy for some of its

*Condensed from an unpublished talk before the American Association for Advancement of Science, Cambridge, Mass.

**A. O. Smith Corporation, Milwaukee, Wisconsin.

Illustrations: Upper Left, The First Introduction of the "Zephyr" to the Public at the Broad Street Station of the Pennsylvania Railroad. This Stainless Steel Train will be placed in service by the Burlington Railroad between Kansas City, Mo. and Lincoln, Neb. (Courtesy Edward G. Budd Manufacturing Company.) Upper Right, The Aluminum Alloy Train of the Union Pacific System. (Courtesy Aluminum Company of America.)

important parts, while one of the most conspicuous products of this new type of metallurgy is cemented tungsten carbide, one member of an important new family of materials for tools. Other products of powder metallurgy are the tungsten-copper heavy duty welding electrode, the new oilless bearings, electrical contacts, and tantalum and molybdenum metal.

A number of new metallurgical processes are now beginning to be used on a large scale from which we may expect valuable results. Copper brazing has been done in the past in an atmosphere of pure hydrogen, but with the development of suitable cheaper gases, this process is assuming real industrial importance as a method of uniting two or more simply-made parts to form a complex composite structure. An analogous process is bright annealing, which avoids scaling and other harmful surface effects with a corresponding saving in subsequent labor. We may also mention the vacuum melting of metals and alloys which has been introduced on a commercial scale by Dr. Rohn in Germany, while the new method of melting by high-frequency current of Prof. Northrup has marked a new era in methods of metallurgical research and is now well established in commercial use as well.

We have briefly mentioned a number of important metallurgical creations which are either of proven value or of great potential merit. With but few exceptions they are of recent date, and are the products of scientific metallurgy. This all reflects a restless activity on the part of our technical scientists, and the rapidity with which these things have been conceived, developed and applied in industry can be traced to the growth of the underlying sciences of physics, chemistry, and metallography, and to the general development of engineering and industry. So important an economic factor does this appear to be that I shall devote a little space to discussing the change from the old, or alchemistic, metallurgy to the new metallurgy, the applied science.

The scientific study of the metals is based on the work of the early metallographists, Sorby, Martens, Osmond, Howe, Prof. Sauveur and others, while of particular significance was the work of the famous Dutch scientist, Roozeboom, who first utilized the principles of the Phase Rule of Willard Gibbs in a study of the constitution of alloy systems. From the knowledge of structure and constitution came the correct understanding of alloying and heat treatment. Furthermore, these principles became broadly available when metallography became a part of the curricula of the technical schools, and clearly enunciated the basic principles in accordance with the scientific method. The effects of the growth and dissemination of this branch of knowledge are clearly evident in the field discussed above, and they are equally as important in the field to which we now turn—new applications of old products such as common steel.

The steel pipe that is used for transporting oil and gas across the country is an old product and has been made by a standardized process, that of lap welding. This process required first that steel be used which is weldable by that process, and secondly that the length of the pipe be not greater than about 20 ft. because greater lengths could not be handled in the welding machine. The effect of the requirement of weldability by lap welding was reflected in the wall thickness of the pipe, and hence in the weight of steel used. Obviously, the weight of steel that had to be bought and transported to the site of the pipe line was a very definite function of the strength of the steel and its weldability. The requirement that the pipe be not longer than 20 ft. was reflected in the number of connections that had to be made in the field. There was thus a very definite tie-up between the metallurgy of steel and the use that could be economically made of the product. Let us see what the effect was when a new method of welding was developed that could weld higher carbon steel of most any thickness and in lengths which were governed only by the transportation facilities. At once the wall thickness was decreased materially, whilst maintaining adequate strength, and the length was increased to 40 ft. The steel itself cost about the same per ton as the weaker type, so the cost of steel for the pipe line was less and the number of field connections was cut in half. This new application of common steel has had a tremendous economical effect, as is attested by the great extension in the long-distance transportation of oil and gas since the introduction of the new pipe.

One factor which dominates the use of an engineering product is knowledge of its reliability in service. Inasmuch as I wish to point out certain extensions of this new welding method that appear to be imminent, some comments on that score will be in order. The method to which I refer was pioneered a number of years ago by the company with which I am associated. Along with other advantages of the electric-arc method of welding, its particular virtue was, and this was new at the time, that it united two pieces of steel with no sacrifice in strength, ductility, or reliability, and did so at a reasonable cost. A particularly illuminating application is given by the large pressure vessels which are now used in refining oil and which operate at high temperatures and pressures. Many hundreds of these are now in daily use with the economic effect of materially increasing the gasoline yield from crude oil, which in turn has the effect of conserving our natural resources.

The welding of pressure vessels provides an ultimate test of the reliability of this method of fabricating steel and from its past successes, we may expect an extension of its applications. One promising field is that of replacing riveted construction, and, in fact, this movement has already commenced. Metallurgists have long considered the riveted joint to be a source of weakness, as is shown by the voluminous literature on stress concentration and corrosion at the joints, while it is recognized that this joint does not make an efficient use of the metal. Even so, up until now there has been no real solution of the problem and the riveted construction has been in use for many years.

Naval circles were stirred a few years ago when the German Navy built a new type of cruiser, fast enough to escape hostile ships which could sink it and powerful enough to sink any hostile ship which could catch it. That accomplishment, assuming that our accounts are correct, was made possible by welding. It is reasonable to expect naval architects to turn their attention to a reliable method of welding to take advantage of the saving in weight and in fuel consumption. Our own navy is vitally interested in saving weight in warships, whether they be treaty ships or not, and hence is not lagging in its study of welding.

Besides the application of welding in the manufacture of lighter, stronger, and more economical ships, it serves also in construction of boilers, buildings, bridges, etc. This may even extend to the new field of steel house construction which was demonstrated at the Chicago Fair.

We come now to a new application of both old and

Illustrations facing this page show: Upper left, Hand-Forged Aluminum Articles; Upper right, Aluminum Foil Packaging; Center, Aluminum Caps and Seals for a Revived Industry; Lower left, Aluminum Collapsible Tubes; Lower right, Package Containers colored by Alumilite Process. (Courtesy Aluminum Company of America.)

Guernsey
FRESH BUTTER HIGH FLAVOR
JERSEY FARM PRODUCTS CO.
LACO
CASTILE SOAP
BOLSTER
WITH ALMONDS
NESTLE'S
HERSHEY'S
5¢ MILK CHOCOLATE 5¢
Schrafft's
LIFE SAVERS
NOAHS
PITCH
GULF
Antiseptic Beard Softener
Barbasol
bali

more recently developed materials, the new high-speed train about which so much has already been written. This project appears to be largely engineering in nature, but it is the existence of proved and tested materials that makes it feasible, namely, the light, strong aluminum alloys, and the corrosion-resistant stainless steels. Without the splendid work of the research and testing organizations of the companies fostering these products, the time would not now be ripe for such a drastic change in the construction of cars for transporting the public at the high speeds which are involved. This movement is too new to allow a proper appraisal of its real significance, though we may secure some ideas of it from a clipping from the daily press. (The Milwaukee Journal) "Building Boom in New-Type Trains to Mean Many Jobs." "The greatest era of railroad equipment building the transportation world has ever experienced is seen for the near future by Omaha railroad men as the result of the new 110-mile an hour streamline trains which the Union Pacific, Burlington, and other railroads are building. They expect to see thousands of workmen taking part in construction of new trains to replace the equipment now in use. As a consequence, they also expect to see the greatest junk pile in all the world, a pile of millions of tons of railroad equipment now rolling over the rails of the nation, a pile that has cost literally billions of dollars, but which will have been made useless, in their opinion, by this new type of train. If this dream comes true conductors and other trainmen will continue in service as usual. And because of the increased number of trains which will be operated, there will be no curtailment in the number of men employed, it is contended. American railroads today operate 50,000 passenger cars, costing around $30,000 each, a total investment of something like $1,500,000,000. There are 4,000 dining cars, costing about $50,000 each, an investment of $200,000,000. New passenger locomotives cost around $60,000 each. There are hundreds of millions of dollars tied up in this equipment now in use on the roads. But the railroaders say all this is doomed just as rapidly as it can be replaced by the new trains. To build the new types rapidly and economically, the present manufacturers of the equipment must rebuild their shops, plan new machines, train new mechanics."

Before leaving the case of the common steels, one should mention two trends which appear to have the ear marks of real progress and which may even reverse the trends to more expensive products. The first of these has to do with what might be called low-alloy steels. Possibly a better term for these would be alloy steels without the special and costly practice which has always been involved in the manufacture of high-grade alloy steels. An example of this is the low-copper steel sheets which have particularly good resistance to atmospheric corrosion as compared with straight carbon steel. Other elements which are used in small amounts to secure improvements in common steels, either alone or in some combination, are chromium, silicon, and manganese, in addition to copper. We might include here such additional elements as nickel, vanadium and molybdenum, which have special virtues when added to steel, even though the special alloy practice be omitted. One application may serve to illustrate the economic importance of such steels. Certain equipment is being manufactured for operation at $-50°C$., and the design is such that heavy steel plates must be used which cannot be given any special heat treatment. Here the low temperature brittleness of straight carbon steel renders it inadequate, but the desired low-temperature properties can be secured by small alloy additions, without otherwise altering the process. Or, again, small alloy additions materially increase the strength of steel at elevated temperatures.

The second trend is improvement in the practice of making steel in the open-hearth furnace, the tonnage of which far exceeds that of all the other steel-making processes. Few people recognize how much metallurgy is involved in the frame of an automobile where it curves up over the rear axle. It is very useful to be able to produce that curve cheaply, but before it was accomplished, a huge investigation of open hearth and rolling mill practice was required.

One might also cite the study made at steel mills on production of large and high-quality steel plates for welded pressure vessels, or nickel steel boiler plate for use in cold countries, or even tin plate that is destined to transport fruit acids. Lack of such knowledge may be a barrier to the introduction of a new product, while its acquisition involves what the technical metallurgist calls the physical-chemistry of steelmaking. This is really an effort to place steelmaking on a scientific basis, and to provide a control of the operations and furnace conditions which will give positive and predictable results. When this is accomplished, much of the uncertainty of the present methods and some of the cost will be eliminated. This is one of the most difficult fields of applied science, but the economic welfare of the country would be served by a vigorous prosecution of this kind of work. Our Government, through its Bureau of Mines, and in coöperation with certain steel companies, at one time did much to foster this work at Pittsburgh, while similar activities are being pushed in England and Germany. Unfortunately, the work of the Bureau of Mines and of its sister Bureau of Standards has been curtailed in a spell of miseconomy, seriously to handicap the development of one of our basic industries. I do not wish to paint too dismal a picture here for our steel industry has demonstrated its ability to keep abreast of the times. I understand, for example, that foreign countries cannot compete with our own steel industry in the important line of steel sheets, not because our tariff keeps them out, but because the foreign sheets do not meet our requirements for quality. What will happen when the foreign makers learn how to raise the quality can be left to conjecture. This movement for improving open-hearth practice, is too powerful and urgent to stop, and our leading producers of steel have established research organizations which compare favorably with those of the non-ferrous and consuming industries. This work should put common steel in a better position to meet the changing requirements of industry, and in the sum total will have a powerful economic effect.

It is worth while to bring out a significant factor in the field of research in the metal industries, though it is impossible to foresee what it will bring forth. We can be sure of one thing, which is that the trained body of scientists in this and other countries will continue its inquisitive search into the unknown, and that new and useful fields will be opened up most unexpectedly. In the case of the stainless steels, who would have known from the work of Brearley in his Sheffield laboratory when he made his observation that certain chromium steels were extraordinary in their chemical resistance, that a new product was in the making, or that Maurer, working in the laboratory of the famous French scientist, Le Chatelier, on the purely academic problem of the retention of the constituent austenite in quenched steels, would uncover the secrets necessary to the thermal and mechanical manipulation of these steels? Who would predict that the academic work on tungsten carbide of

Stainless Steel Articles (Courtesy Republic Steel Corporation)

twenty ears ago would some day give the hard facing for oil well drills that enable man to dig deeper into the crust of the earth in search for oil and thus to put otherwise hidden treasure to work? Who would predict that a mistake made in treating tungsten in a hydrogen atmosphere when a piece of copper wire accidentally came in contact with the tungsten would lead to the new process of copper brazing? Who would have predicted from the work of Dr. Merica when, as a government employee, he solved the problem of the micromechanism of age-hardening in Duralumin, or when at about the same time similar conclusions were reached in the laboratories of Rosenhain in England, and of Guertler in Germany, that a new process for hardening and strengthening alloys was about to be given to the world, later to lead to that important class of age-hardening alloys? The basic sciences are economic factors.

While metallurgical developments comprise but one phase among many that arise from basic science in the view of a practicing metallurgist, metallurgy deserves to be acclaimed as one of the most powerful economic factors in modern industry.

EDITORIAL COMMENT

(Continued from page A 19)

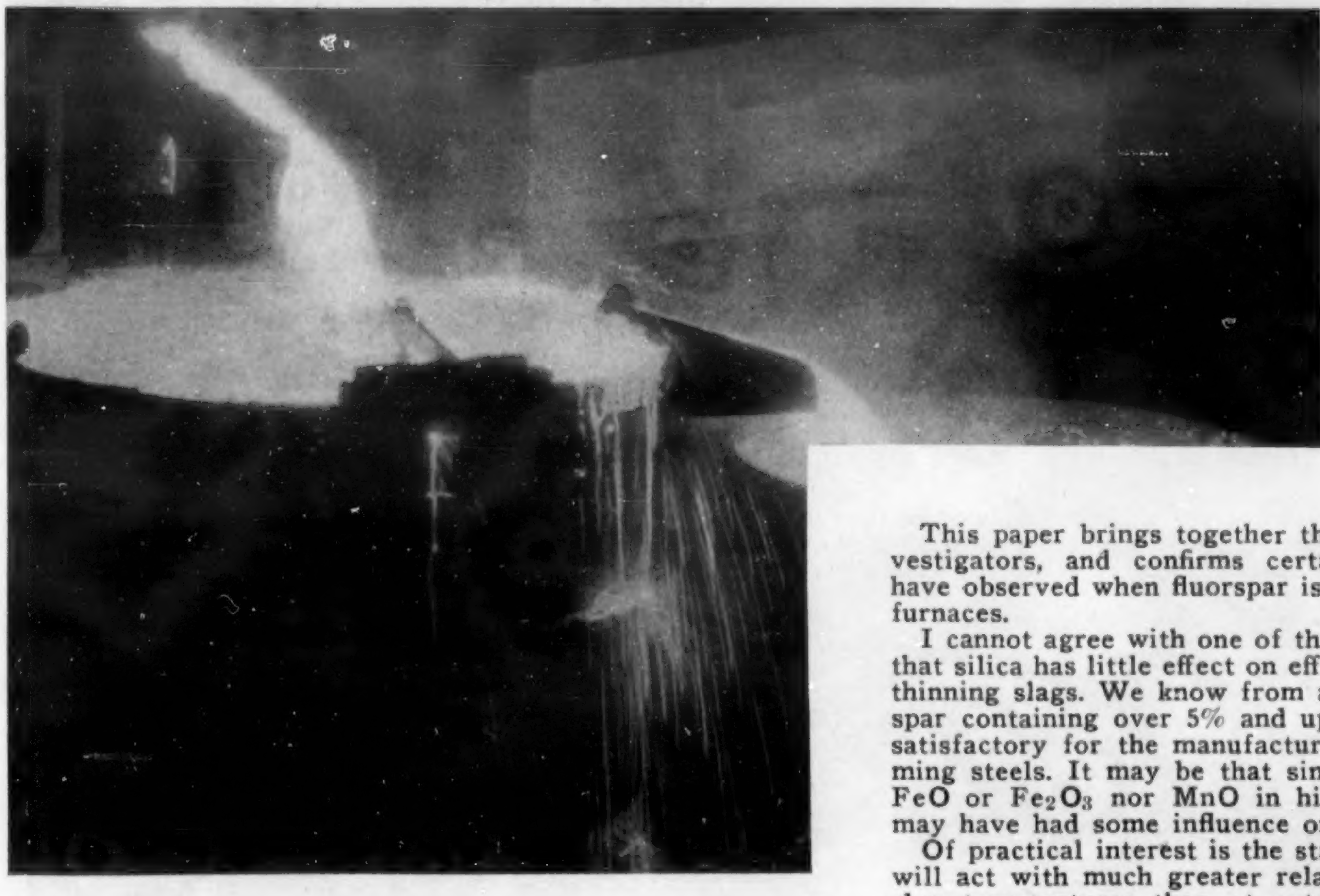
easily or better handled by individual effort. It is equally important to know where to stop and where to begin coöperative research. (4) The management of coöperative work, as in private enterprises of this kind, should be centered in one executive who may be Chairman of an advisory committee, and he in turn should delegate the technical work to a qualified man who should be held responsible for the details. The duties of the Committee are to raise the necessary money, contact the members of the contributing group, and decide all questions of policy. The duties of the technical director are clear and definite—to find the most satisfactory solution to the problems assigned as far as possible. Both will have their advisory contacts among financial contributors and others who may be able to assist directly or indirectly in working out the problem.

A few specific examples might be cited of problems that have been successfully worked out on a coöperative basis:

Corrosion of metals involves many problems that can be best handled in this way. A few years ago the American Society of Refrigerating Engineers decided to see what could be done towards eliminating corrosion of tanks, ice cans, and other apparatus due to corrosive brine. A small committee of refrigerating engineers was formed, two or three interested manufacturers' representatives were invited to coöperate, and plans were soon under way. A survey of the problem was first instituted, and data collected from the work already reported in the literature. It soon became evident that the line of least resistance was the use of inhibitors in the brine. It had been predicted by Evans and others that the chromates were unreliable in the presence of high chloride concentration, but some preliminary work indicated that while complete protection could not be predicted, this might be the most economical procedure so that these were included with other inhibitors for study. It was estimated that the work would require two years in the laboratory. A technical assistant was engaged on full time and a contract made with the Massachusetts Institute of Technology Research Laboratory. Funds required, about $8,000, for a period of two years were soon subscribed and the work started. After the first year plant tests

(Continued on page MA 304)

The Effect of FLUORSPAR



Photograph, Courtesy Andrews Steel Company

This paper brings together the ideas of several investigators, and confirms certain results operators have observed when fluorspar is used in metallurgical furnaces.

I cannot agree with one of the author's conclusions that silica has little effect on efficiency of fluorspar in thinning slags. We know from actual experience that spar containing over 5% and up to 15% silica is not satisfactory for the manufacture of low carbon rimming steels. It may be that since the author had no FeO or Fe_2O_3 nor MnO in his synthetic slags this may have had some influence on his results.

Of practical interest is the statement that fluorspar will act with much greater relative efficiency at low slag temperatures than at extremely high temperatures.—L. F. Reinartz

on the Viscosity of Basic Slags*

by Lenher Schwerin

THE PRIMARY function of fluorspar when added to basic slags in open hearth and electric furnaces making steel and cupola furnaces melting iron is to decrease the viscosity of those slags. The importance of control of the fluidity of slags becomes apparent when one realizes that the success of the refining process depends largely upon the reactions which occur between the slag and the underlying bath of metal and upon the transfer of heat through the slag to the metal. Equilibrium is rarely attained, but it is evident that the velocity of the chemical reactions and the rate of heat transfer depend in turn upon the diffusion and convection of reactants toward the slag-metal interface and of the products away from there. Also, the transfer of heat by convection in a fluid medium is far more rapid than by conduction alone. Thus, it is clear that the speed of these processes in the slag is governed by its mobility or fluidity.

Since little is known quantitatively about the effect of fluorspar on the viscosity of slags, an investigation was undertaken by the writer for the purpose of throwing light on this important question. This paper presents the results of measurements of the temperature-viscosity relations in some basic quaternary slags before and after the addition of fluorspar in increasing amounts.

*Abstracted from a thesis presented in partial fulfillment of the requirements for the degree of Doctor of Philosophy, Department of Mining and Metallurgy, University of Wisconsin.

Choice of Slags

The slags were synthetic and were selected from that part of the quaternary system lime-alumina-silica-magnesia which approximates the composition of actual basic open hearth slags in the relative proportions of these 4 components. Table 1 gives the analyses of several actual basic open hearth slags which are considered typical and from consideration of which the compositions of the synthetic quaternary slags were chosen.

In this connection a very important consideration was the material that composed the crucibles and spindles with which the viscosity determinations were to be made. A high-frequency induction furnace was used in the viscometer employed in this investigation. When a non-conducting charge is being heated in the induction furnace the crucible must be a conductor of electricity or be enclosed by a conducting sleeve. The refractory should resist the attack of slag at temperatures up to 1650°C. such as obtain in steel-making furnaces and should not become weak at such temperatures; it should also be resistant to thermal shock. Platinum-10% rhodium seems to satisfy these requirements, but its cost was prohibitive. The only other material available which approached the above specifications was graphite. It may be bought in the form of cylindrical electrodes of suitable diameter which can be easily cut to length and turned on a lathe.

The choice of graphite imposed a restriction on the composition of the slags. Actual basic open hearth slags

contain considerable amounts of such oxides as FeO, Fe_2O_3, MnO and P_2O_5 (Table 1). These oxides are easily and quickly reduced by graphite at steel-making temperatures. It was this fact that made it necessary to deal with synthetic lime-alumina-silica-magnesia slags and omit the reducible oxides.

That the restrictions imposed upon the composition of these slags in no way invalidates the conclusions which have been drawn from the results of the experiments, will be evident later when comparison is made with the data obtained by another investigator who worked with actual basic open hearth slags in platinum crucibles.

Table 1. Composition of Typical Basic Open-Hearth Furnace Slags

Five Tapping Slags, after Geiger[1]

SiO_2	15.32	13.97	9.30	11.63	17.04
CaO	42.63	47.20	40.84	46.39	44.63
P_2O_5	2.08	3.89	1.75	2.67	1.97
MgO	8.37	9.98	9.32	7.98	8.23
MnO	9.49	7.63	8.73	10.53	7.63
FeO	13.90	10.53	21.91	16.09	12.48
Fe_2O_3	4.88	6.28	5.79	1.73	5.50
Al_2O_3	1.93	1.03	1.51	2.67	2.10
TiO_2	1.08	..	.73	.37	..
S	.21	.18	.27	.24	.23
Total	99.89	100.69	100.15	100.30	99.81

Average from 25 Heats Making One Grade of Steel (C 0.086, Mn 0.20, P .010, S .030) at South Chicago Plant of Illinois Steel Co., Before Additions. After Janitzky.[2]

SiO_2	Al_2O_3	TiO_2	FeO	Fe_2O_3	MnO	CaO	MgO	P_2O_5	S
13.55	2.18	0.37	14.93	5.01	9.67	42.40	9.51	1.92	.030

Three German Tapping Slags from Low Carbon Heats, After Schleicher.[3]

SiO_2	15.20	19.63	18.25
Fe_2O_3	3.57	2.86	2.71
FeO	8.14	11.57	11.70
Al_2O_3	2.14	3.36	2.51
MnO	5.41	5.63	16.02
P_2O_5	4.76	2.62	2.13
CaO	46.50	45.98	35.50
MgO	12.97	4.55	7.15
S	0.32	0.44	0.24
CaF_2	..	2.26	3.49

Viscosity Apparatus

The method for the determination of the temperature-viscosity relationships is based on the principle of the Margules[4] rotating cylinder. The viscometer is that which had previously been used for the determination of the viscosity of iron blast-furnace slags by Prof. R. S. McCaffery and Coworkers of the Department of Mining and Metallurgy, University of Wisconsin, and has been described in great detail in their paper.[5]

Briefly, the slag of which the viscosity is to be measured is placed in a graphite crucible supported so that it may be rotated at constant speed within a high-frequency induction furnace. The crucible is the secondary of the electrical circuit and in it is induced a current which generates the heat that keeps the slag at the desired temperature. A graphite spindle suspended by a torsion element is immersed in the molten slag. The slag in the rotating cylinder exerts a torque upon the spindle, whose angular displacement is measured by a beam of light reflected from a mirror attached to the upper part of the spindle. Temperatures are measured by an optical pyrometer sighted from above upon the surface of the slag. The crucible-spindle system having been calibrated with castor oil of known viscosity, simultaneous readings are taken of slag temperature and spindle displacement at a known speed of crucible rotation.

The viscosity in poises may be calculated from the above data by the following expression:

$$\eta \text{ (poises)} = \frac{K\phi}{S}, \text{ in which}$$

K = constant for the spindle suspension element
ϕ = the total angle of deflection in degrees (equal to the sum of the angles of incidence and reflection)
S = speed of crucible in revolutions per minute.

McCaffery and Coworkers introduced numerous refinements in the method. An important modification was the substitution of a square spindle for the round one used

Courtesy Andrews Steel Company

by previous investigators. The method is based upon the fact that the force required to cause slip or shear between concentric layers of slag is a true measure of viscosity. Graphite is not always wetted by slag. Unless the adhesive force between spindle and slag is greater than the cohesive force between concentric layers of the slag, slip will not take place between those layers but between the slag and the spindle. Therefore, with a round graphite spindle, deflections may be erratic and a true measure of slag viscosity will not then be obtained. They experimented with a number of spindle shapes designed to entrap the slag and prevent slip at the spindle surface. The square spindle was among the various shapes found to give consistent measurements and it was adopted because of its sturdiness and the simplicity of forming it as compared with the more complicated ones.

From inspection of the formula

$$\eta = \frac{K\phi}{S}$$

it is evident that the criterion for viscous flow in the apparatus is that the angular deflection is proportional to the speed of rotation. That is, the relationship between these 2 variables is represented by a straight line passing through the origin, which is what McCaffery and Coworkers found for both round and square graphite spindles in castor oil. This disposes of the objection which has been raised that turbulence might occur at the spindle corners.

Verification of the correctness of the square graphite spindle was later obtained when the viscosities of identical samples of slag were measured in the viscosity apparatus with the square graphite spindle and in a similar apparatus having a cylindrical platinum spindle, designed by Lillie[9, 10] to give absolute viscosities. Slags do wet platinum; therefore slip does not occur at the spindle surface. The results of the measurements were in agreement well within the limits of experimental error.*

Preparation of Slags

The slags were made from the pure oxides. These had been carefully dried so that a desired composition could be approximately obtained by weighing out the correct proportions of the components. The batches weighed

*See *Transactions American Institute of Mining & Metallurgical Engineers*, Iron and Steel Division, Vol. 100, 1932, pages 104-111.

700 g. and were carefully mixed by rolling on a large sheet of smooth paper. To prevent dusting and consequent loss during melting, caused by expansion of occluded air, the batches were moistened and then dried, producing cakes which were broken up. The charges were then melted in a large graphite crucible in the induction furnace and cast onto an iron plate. After grinding and mixing, the charges were remelted and cast and ground up again to pass a 20-mesh screen. This resulted in a fairly homogeneous mix. However, due to crystallization of slag minerals, complete homogeneity is not immediately attained when such slag is remelted in the viscosity crucibles. If viscosity readings are attempted soon after the slag becomes molten, erratic and false values are obtained. In all cases, therefore, the slag was kept molten at least 100°C. above its melting point for an hour, during which time equilibrium was attained by diffusion.

Operation of the Viscometer

The quantity of slag required for one viscosity determination is about 105 g. After the slag has become molten the spindle is suspended in place by a procedure that insures constant submersion and uniformity of slag volume. The spindle is centered in the crucible and the mirror adjusted so that the beam of light is reflected to the center of the scale. Readings are taken as the slag cools slowly from the highest temperature at which values are desired. The speed of rotation of the crucible is kept constant, measurements being made frequently with an accurately calibrated tachometer. The temperature and corresponding deflections of the beam of light are read simultaneously at short intervals, two observers being necessary.

A series of readings while the slag slowly cools occupies about ½ hour. In all cases the slag was again heated and at least one check run of readings made. This was not only for the purpose of reducing experimental error but to determine whether change of composition by volatilization resulted in any appreciable change in viscosity. Some samples of a particular slag show a greater tendency to carbide formation than others. If the carbide is observed to form a layer on top of the slag or build an accretion on the spindle, as sometimes happened, such heats have to be repeated with a new sample. Care must also be exercised to avoid taking readings when fumes are being given off, as the apparent temperature would be too low.

After the viscosity of a given sample of slag had been determined, 4 g. of pure CaF_2 were added to the melt. Viscosity readings were then commenced within 5 minutes of the addition and again after about an hour. The time interval before taking the second set of readings is for the purpose of insuring that the spar is uniformly mixed with the slag (the crucible being kept revolving meanwhile) and to allow any reactions which may be taking place between the spar and the slag to go to completion or at least make themselves apparent. Such a reaction is

$$2CaF_2 + SiO_2 = 2CaO + SiF_4.$$

The slag is then cooled and kept for chemical analysis.

A second and third sample of the original slag is used in identical manner, viscosity determinations being made both before and after the addition of 8 and 12 g. of fluorspar, respectively.

Discussion of Results

These data are represented graphically in the form of temperature-viscosity curves. The figures represent the slags to which 0, 4, 8, or 12 g. of calcium fluoride had been added.

The curves of each series of slags show a pronounced displacement to the left as the amount of fluorspar increases, the displacements being about equal for each increment. It will be noted that the effect of adding fluorspar is analogous to increasing the temperature. As the temperature of each slag increases, the viscosity approaches a minimum value characteristic of that slag. For any particular molten slag, the lower its temperature the more pronounced is the effect of a given fluorspar addition. For example, in Fig. 1 consider slag No. 1, which contains no fluorspar, and compare it with slag No. 2, which represents the same slag with a given fluorspar addition. At a temperature of 1575°C. slag No. 1 has a viscosity of 16.8 poises and the given fluorspar addition will decrease the viscosity to 2.4 poises. However, at a higher temperature, say 1675°C., slag No. 1 has a viscosity of 2.7 poises and the same fluorspar addition as before will decrease the viscosity to 1.8 poises, which is a much smaller decrement.

Table 2 gives the chemical composition of the slags after the viscosity measurements were made.

An extremely important consideration in evaluating the data from a practical point of view is the question whether the action of fluorspar on these quaternary slags is analogous to its action on actual basic open hearth slags. Fortunately, the temperature-viscosity relations in some actual slags containing varying amounts of calcium fluoride has recently been determined by Matsukawa.[6] The viscosity curves for his slags are reproduced in Fig. 7 and the corresponding analyses in Table 4. It should be noticed that the form of those curves and their relative displacement to the left with increasing fluorine content is practically identical with the writer's curves for quaternary slags. Concerning his slags, Matsukawa states in a private communication to the writer that 1% F lowers the melting temperatures about 100°C. The amount of fluorspar added to those slags was from 0.3 to 5%, of which 15 to 16% of the CaF_2 remained in the slags. His analyses show that the losses of F and Si correspond to the ratio SiF_4. This indicates that the following reaction takes place:

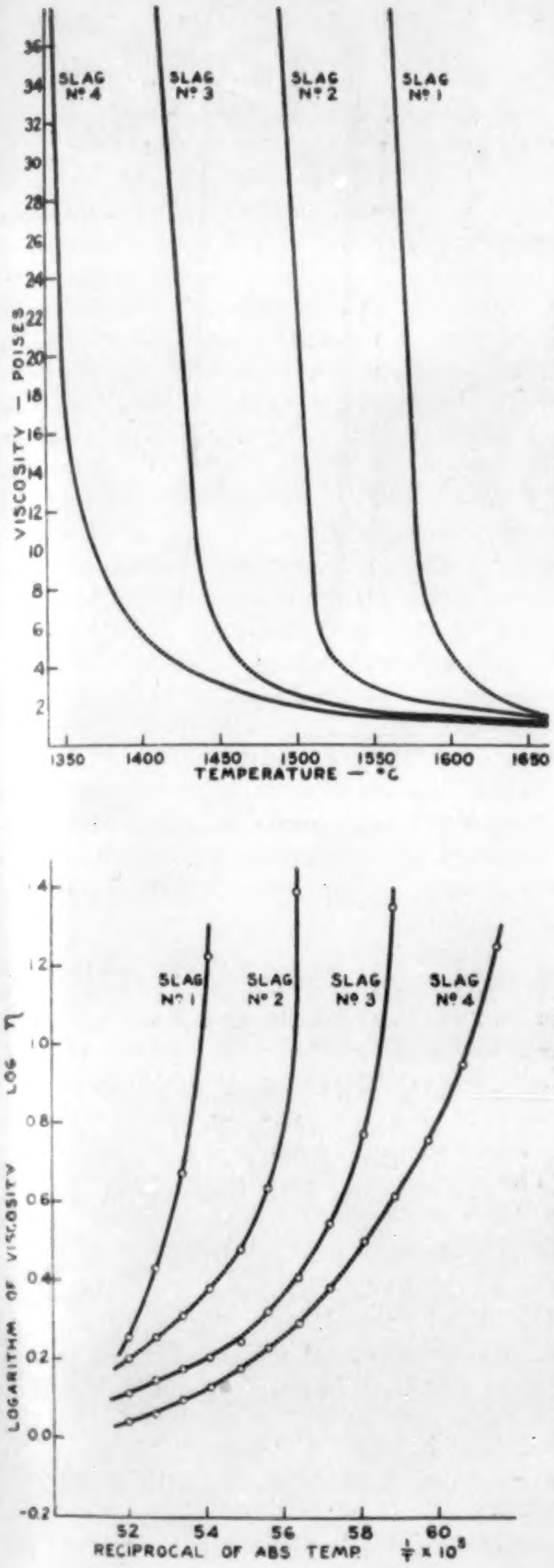
$$2CaF_2 + SiO_2 = 2CaO + SiF_4.$$

Although some fluorine is lost and the slag becomes slightly more basic due to the formation of one molecule of lime and the loss of ½ molecule of silica for each molecule of calcium fluoride reacting, the actual change in composition of the slag in this manner is negligible as compared with the effect of the amount of calcium fluoride which remains.

Table 2
Chemical Composition, %

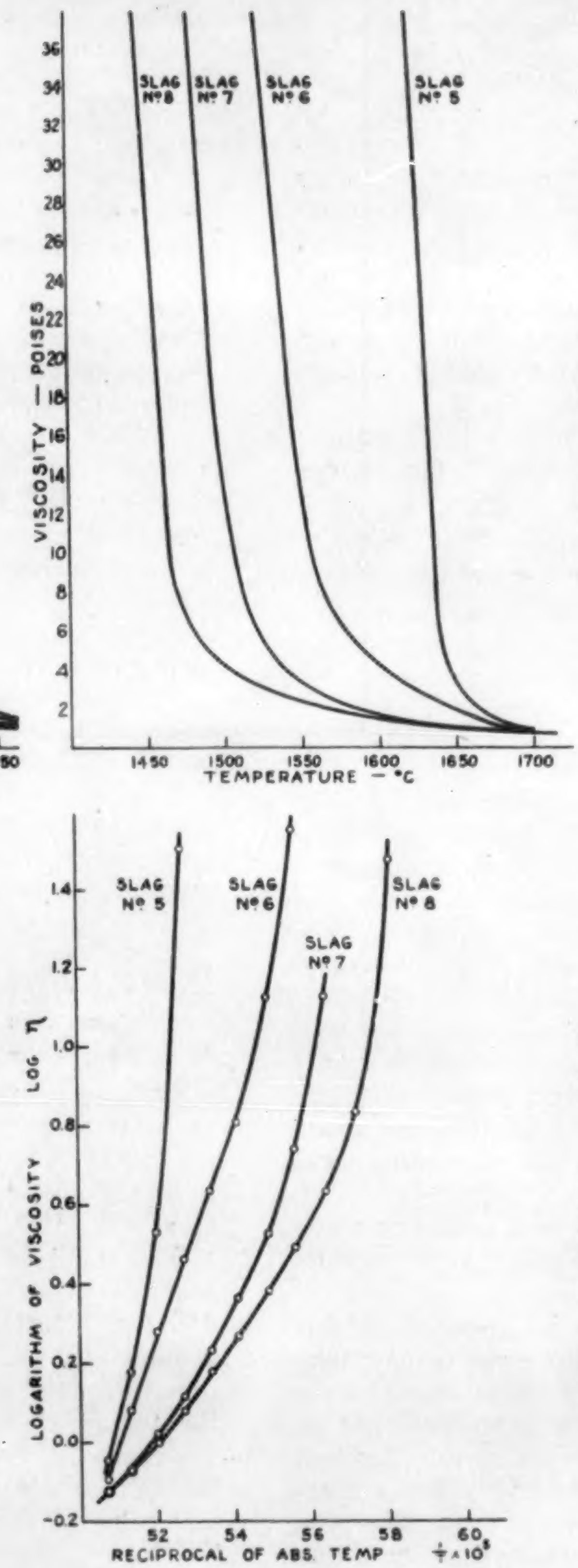
Slag No.	SiO_2	Al_2O_3	CaO	MgO	F	CaF_2	Total
1	33.88	5.34	54.68	5.81	..		99.71
2	32.84	5.88	54.92	5.98	0.35	(0.72)	99.97
3	34.78	5.30	53.72	5.38	0.56	(1.15)	99.74
4	32.20	5.42	55.30	5.32	1.69	(3.47)	99.93
5	25.56	5.90	55.50	12.90	..	..	99.86
6	28.48	5.76	59.58	5.65	0.38	(0.78)	99.85
7	26.36	5.58	59.74	7.58	0.56	(1.15)	99.82
8	26.00	5.82	60.01	6.72	1.27	(2.61)	99.82
9	27.98	5.90	55.72	10.19	..	..	99.79
10	28.41	5.87	55.00	10.24	0.35	(0.72)	99.87
11	26.84	6.10	56.40	9.45	1.06	(2.18)	99.85
Spar	0.05	..	1.20	..		98.75	

Losana[7] has recently reported the results of measurements of viscosities of some acid and basic open hearth furnace slags. His viscometer made use of a graphite crucible containing the molten slag, in which was immersed a rotating graphite rod. The temperature-viscosity curves so obtained are peculiar, exhibiting maxima and minima instead of the usual approximation to the hyperbola. To four of these slags, having the composition given in Table 2, he added varying amounts of fluorspar up to 10% and found for the first 3 slags that additions



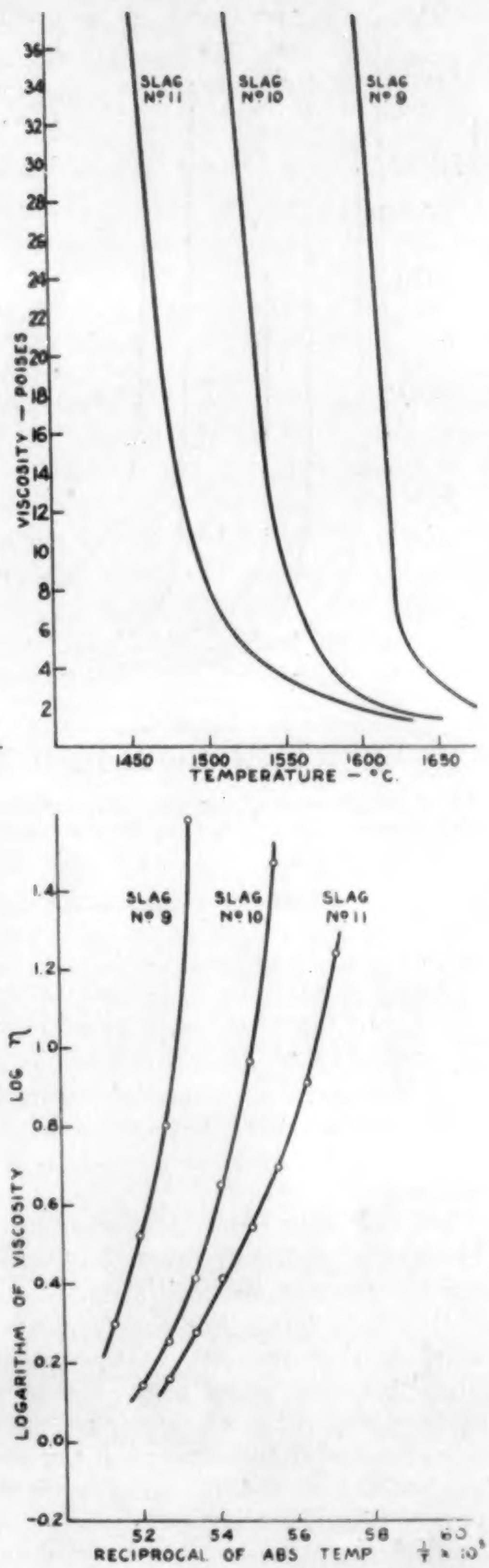
Figs. 1 and 2

Slag No.	1	No addition.
Slag No.	2	4 g. CaF_2 added.
Slag No.	3	8 g. CaF_2 added.
Slag No.	4	12 g. CaF_2 added.



Figs. 3 and 4

Slag No.	5	No addition.
Slag No.	6	4 g. CaF_2 added.
Slag No.	7	8 g. CaF_2 added.
Slag No.	8	12 g. CaF_2 added.



Figs. 5 and 6

Slag No. 9	No addition.
Slag No. 10	4 g. CaF_2 added.
Slag No. 11	8 g. CaF_2 added.

Table 3

Viscosity in Poises at Temperature °C.

Slag No.	1350	1375	1400	1425	1450	1475	1500	1525	1550	1575	1600	1625	1650	1675	1700
1										16.8	4.7	2.7	1.8		
2							24.5	4.3	3.0	2.4	2.1	1.8	1.6		
3				22.4	5.9	3.5	2.6	2.1	1.7	1.6	1.5	1.4	1.3		
4	17.8	8.9	5.7	4.1	3.2	2.4	2.0	1.7	1.5	1.4	1.3	1.2	1.1		
5												31.9	3.4	1.5	1.0
6								36.0	13.4	6.4	4.3	2.9	1.9	1.2	0.8
7							13.5	5.5	3.4	2.3	1.7	1.3	1.1	0.8	0.8
8					30.1	6.8	4.2	3.1	2.4	1.9	1.5	1.2	1.0	0.8	0.8
9											38.6	6.4	3.4	2.0	
10								29.7	9.3	4.5	2.6	1.8	1.5		
11						17.5	8.2	5.0	3.5	2.6	1.9	1.4			
Spar				0.34	0.30	0.27	0.25	0.23	0.20	0.15					

of up to 5% decreased the viscosity, but with larger additions the viscosity again increased. The acid slag showed a continuous decrease in viscosity with increased fluorspar. With the exception of this last slag, his results seem extraordinary. The explanation probably lies in the fact that these slags contained the oxides of iron and manganese which, according to the present writer's experience, are quickly reduced to metal when in contact

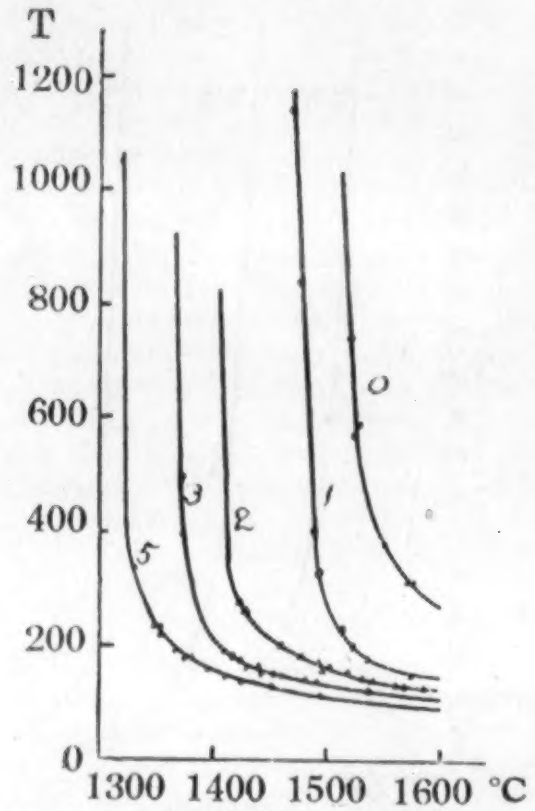


Fig. 7. Temperature-Viscosity Curves for Various CaF_2 Contents (See Table 4) by Mutsukawa.

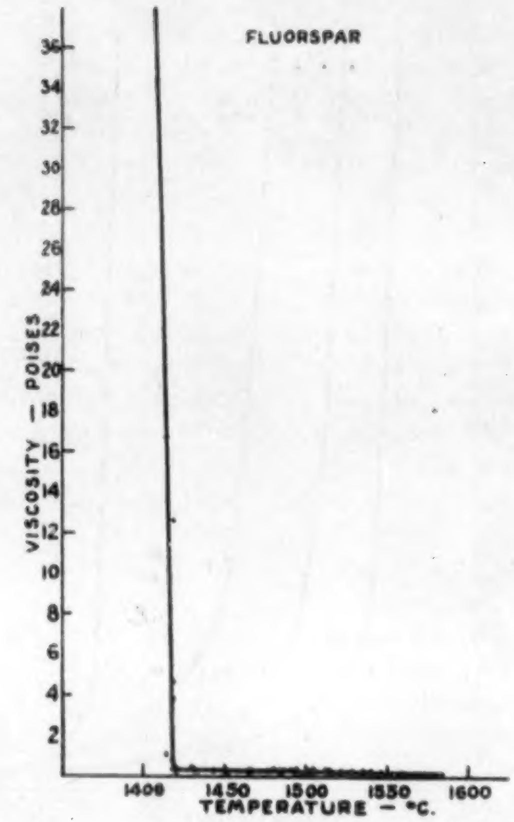


Fig. 8

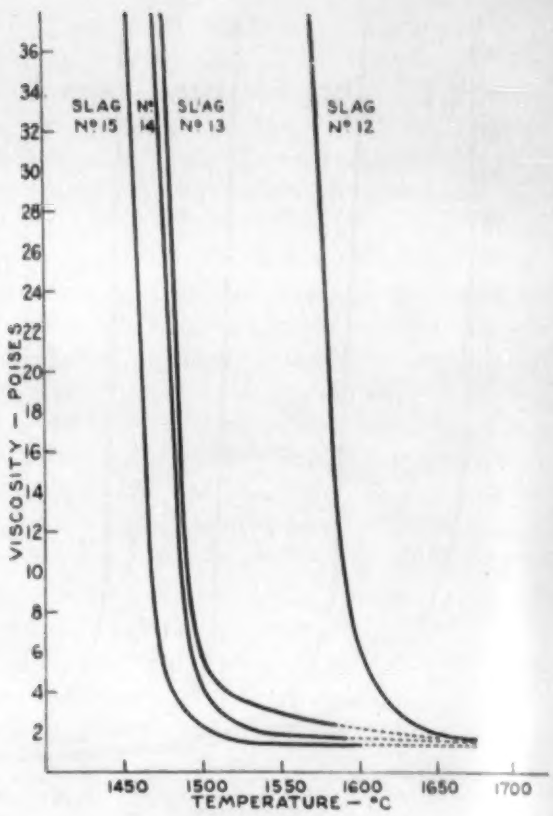


Fig. 9

Table 4. Compositions of Slags in Fig. 7

Slag No.	(F)	CaF_2	CaO	SiO_2	MnO	FeO	MgO	Al_2O_3	P_2O_5	S
0	0.188	0.386	36.63	20.40	11.05	12.34	12.38	2.70	4.78	0.207
1	0.356	0.731	36.45	19.92	10.97	12.18	12.30	2.49	4.76	0.192
2	0.743	1.526	36.13	19.64	10.43	12.12	12.06	2.34	4.71	0.189
3	1.209	2.484	35.61	19.40	10.35	12.04	11.84	2.07	4.59	0.187
5	1.988	4.084	35.02	18.96	10.28	11.76	11.61	2.26	4.43	0.175

Table 5

No.	SiO_2	CaO	FeO	Fe_2O_3	MnO	Al_2O_3	MgO	P_2O_5	S
21	21.7	43.6	12.5	1.3	12.5	3.4	3.7	0.80	0.12
22	18.5	46.5	11.2	3.8	9.7	3.1	4.6	0.92	0.18
25	25.2	38.6	7.3	10.9	5.3	4.2	5.8	1.62	0.08
30	48.5	12.6	21.6	2.7	4.3	3.2	4.9	0.22	0.10

with graphite at steel-making temperatures. It seems unlikely that the composition of Losana's slags would not change considerably while a series of readings was made.

On the other hand, Matsukawa used a platinum crucible and a platinum covered spindle, so that his results are not open to this criticism.

One very important conclusion to be drawn from this work is that in spite of the reaction which may take place between silica and calcium fluoride immediately upon the addition of fluorspar, the reaction does not go anywhere near to completion, as shown by the chemical analyses, and the lowering of viscosity is not a temporary effect, but lasts an hour or two at least. This was confirmed in every viscosity determination, readings which were begun within 10 minutes of the fluorspar additions being always repeated after the elapse of at least an hour, and in one case 2 hours, without any diminution of the effect being detected. Evidently an equilibrium is established in the slag between the calcium fluoride and the silica, perhaps due to neutralization of the latter by the excess of CaO present.

Viscosity of Fluorspar

Fig. 8 shows the viscosity of molten fluorspar whose composition is given in Table 2. The fluidity at temperatures above 1420°C. as compared with that of the slags whose viscosities were measured is striking, and suggests the possibility that the fluidity conferred upon slags by fluorspar additions is an additive one. However, this does not seem to be a sufficient explanation to account for the magnitude of the effect of small additions.

Silica in Fluorspar

A 100-ton basic open hearth heat will carry around 25,000 lbs. of slag, to which may be added from 500 to 1500 lbs. of fluorspar, according to Geiger.[1] The slag may contain 10 to 20% SiO_2. Assuming 15%, that amounts to 3750 lbs. of SiO_2. If the fluorspar contains 5% SiO_2, only 25 to 75 lbs. will be added to the slag, quite insignificant as compared with the amount already there.

The standard specification for metallurgical fluorspar requires a minimum of 85% CaF_2 and a maximum of 5% SiO_2. If the silica exceeds this figure by a small amount and the spar is accepted nevertheless, it is customary for the steel-maker to impose a penalty based on the theory that each unit of silica renders ineffective 2½ units of calcium fluoride. Evidently the basis for this is that when calcium fluoride reacts with silica, two molecules of the former combine with one molecule of the latter, the molecular weights being 2x78.07 and 60.06 respectively, which are in the ratio of 2½ to 1, approximately.

But when fluorspar in small quantities is added to basic slag, as in the open hearth process, it quickly melts and is diluted by the slag. The silica-calcium fluoride reaction does not go to completion, but quickly reaches equilibrium. The conditions that obtain, therefore, are not the same as if the fluorspar were melted with silica alone.

It would appear that when fluorspar is added to a basic slag the relatively small silica content of the fluorspar should have little effect upon its efficiency. To test this experimentally, measurements were made of the viscosities of 3 identical 105 g. portions of slag to each of which were added 8 g. of calcium fluoride, free of silica in one case and mixed with 9.1 and 16.7% SiO_2 in the other two. The slag before melting had the following approximate composition: CaO 48.5%, MgO 14.4%, Al_2O_3 5.3% and SiO_2 31.8%. The additions of fluorspar with silica were prepared by intimately mixing powdered calcium fluoride and silica flour. The slag in each case was heated to pastiness and the addition,

wrapped in an ashless filter paper, was dropped onto the surface and then submerged with the spindle. The slags and additions were as follows:

Slag No. 12	No addition
Slag No. 13	8.0 g. CaF_2 free of silica
Slag No. 14	8.0 g. CaF_2 + 0.8 g. SiO_2
Slag No. 15	8.0 g. CaF_2 + 1.6 g. SiO_2

The temperature-viscosity curves of the 4 slags are assembled in Fig. 9 for comparison. It is evident that the fluorspar containing the silica is no less effective in decreasing the viscosity of the slag than the fluorspar free of silica. Since the slag was very basic, the effect of the silica in the additions, far in excess of that added in actual practice, was to augment the effect of the fluorspar by rendering the slag less basic.

Viscosity and Molecular Aggregation

For a long time the association of molecules in many liquids and the existence of so-called liquid crystals in certain organic compounds has been recognized.[8] With such substances as p-azoxyanisole and p-azoxyphenetole the early observations were that immediately above the melting-point and over a temperature range the liquid exhibited a marked turbidity and double refraction, as well as interference colors when examined by polarized light. X-ray analysis showed no evidence of a true space-lattice structure, but rather an orientation of the molecules, with their axes parallel, into aggregates or swarms. The turbidity is due to random arrangement of the aggregates. While some of these anisotropic liquids assume a perfectly spherical shape when a drop is suspended in a liquid of the same density, others have been found that exhibit "a multitude of different forms, some of which are characterized by considerable grace and symmetry."[9] If the liquids are heated further, they become isotropic at definite temperatures, and on cooling, the reverse series of changes occur; the process is enantiotropic. Considerable interest has been evinced in liquid crystals and anisotropic melts. Ornstein and Kast[10] have recently written, "Apparently every liquid which has not spherically symmetrical molecules forms swarms, in the immediate neighborhood of the melting-point, of the same kind as are stable for liquid crystals over a larger temperature range." This general idea is confirmed by Stewart and a number of other authorities, who have contributed to the Faraday Society's symposium on liquid crystals and anisotropic melts.[11] Ornstein and Kast[10] add, "The size of the swarms decreases with rise of temperature, as determined from measurements of their double refraction and their diamagnetic and dielectric anisotropy." Sosman[12] has stated that "We have definite evidence that in the liquid state of silica, the unit of structure is larger than the simple atom-triplet SiO_2." And Lawrence[13] concludes that, "Any solution having a structure may be expected to have a high viscosity."

If the existence of aggregates of molecules in liquids offers the correct explanation of the observed fact that the viscosity of molten slags increases sharply as the freezing point is approached, it would seem reasonable to suppose that the effect of fluorspar is either to inhibit the formation of molecular aggregates, or by lowering the freezing point to displace their formation and growth to a lower temperature.

Conclusions

1. Regarding the viscosity of a basic slag, the effect of adding fluorspar is analogous to increasing the temperature.

   A. For a particular molten slag, the lower its temperature the more pronounced is the effect of a given fluorspar addition.

   B. At a given temperature the effect of fluorspar is a direct function of the amount added.
2. The decrease in viscosity of a slag caused by the addition of fluorspar is not a temporary effect, but lasts an hour or two at least, *provided* no other materials enter the slag to change its composition meanwhile.
3. The presence of silica in fluorspar, within the limits investigated, does not lower the efficiency of the calcium fluoride, per unit added, in decreasing the viscosity of the slag.

Acknowledgment

The author takes pleasure in expressing appreciation to Prof. R. S. McCaffery, Chairman of the Department of Mining and Metallurgy, University of Wisconsin, under whose direction the investigation was carried out, for his advice and permission to use the facilities of the Department. He wishes to thank Prof. Scott Mackay for his good counsel and valuable criticism throughout the investigation and Dr. J. F. Oesterle and other members of the Department for their interest and ready coöperation. In the manipulation of the viscosity apparatus the author was ably assisted by Dr. O. O. Fritsche.

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Dr. Norman E. Woldman, formerly metallurgical engineer for Westinghouse Electric & Manufacturing Co., has opened his own consulting chemical and metallurgical laboratories at 10616 Euclid Avenue, Cleveland, Ohio, under the name "Crystal Engineering Laboratories." Dr. Woldman taught chemistry and metallurgy at the University of Maine and the University of Illinois, and was head of the department of metallurgy and chemistry at the United States Naval Academy Postgraduate School, Annapolis, Maryland. Dr. Woldman is the author of many technical papers and has published one college text book, entitled "Physical Metallurgy." His second book on the subject of Engineering Alloys is now in the hands of the publisher ready for publication.

Dr. F. M. Becket Granted Degree

On May 29th, McGill University conferred the degree of LL.D on Dr. F. M. Becket, president of the Union Carbide and Carbon Research Laboratories, Incorporated; and vice-president of the Union Carbide, Electro-Metallurgical, and Haynes Stellite companies, and some other affiliates of the Union Carbide and Carbon Corporation.

He is a member of many of the scientific and technical societies, having served as president of the American Electrochemical Society (1925-26), and vice-president and a director (1932) and president (1933) of the American Institute of Mining and Metallurgical Engineers. Columbia University conferred the degree of ScD. on Dr. Becket in 1929.

Dimensional Changes in

DIE CASTING ALLOYS

Metastable Beta Phase in Aluminum-Zinc Alloys**

by R. G. Kennedy*†

IV. Effect of Temperature and of Magnesium Additions on the Rate of Decomposition of the Beta Phase.

According to Merica[8] and others, the mobility of Zn and Al atoms in an alloy of these metals is appreciable even at room temperature. Hanson and Gayler[4] were able to retard the decomposition of the β phase by maintaining the specimen at 0°C. and this fact suggested the investigation of the effect of aging at sub-zero temperatures.

1. *Effect of Temperature on Rate of Decomposition of Beta Phase.* a. *Age Hardening*—Specimen Z (78.3% Zn, Table 2), was heated to 350°C. for ½ hour and quenched in ice water. After quenching, the specimen was kept immersed in ice water even while the hardness readings were taken on the baby Brinell machine. A small copper cylindrical vessel (4 inch diameter), held the ice bath and the specimen on the hardness machine. The 1/16 inch ball and holder were also kept in ice water between readings so that both the ball and the specimen were practically always at the same temperature. Specimen A (85% Zn, Table 2), after being quenched and aged at 0°C. was tested in the same way. Fig. 10 shows the time-hardness curves for the 2 alloys. A comparison with Fig. 4 shows that the maximum hardness for alloy Z when aged at 0°C. was delayed so that it occurred 35 minutes after quenching instead of 6 minutes (Fig. 4). Likewise, the maximum for alloy A occurred 15 minutes after quenching instead of 1½ minutes.

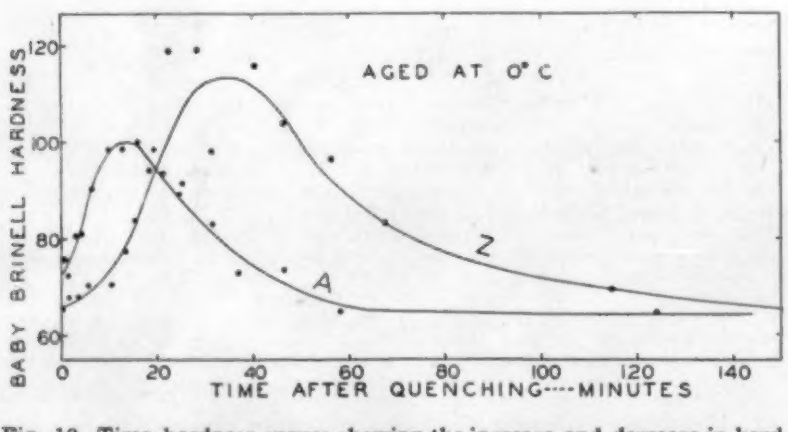

Fig. 10. Time-hardness curves showing the increase and decrease in hardness of specimen Z (78.3% Zn) and specimen A (85% Zn), aged in ice water.

The effect of a lower aging temperature than 0°C. was next considered. Specimen Z was heated to 350°C., quenched in ice water and immediately placed in a sludge of acetone and solid carbon dioxide (approximately -70°C.). The specimen was maintained under these conditions for 70 minutes, hardness readings being taken at intervals while at this temperature. Fig. 11 shows that the hardness remained fairly constant during aging at -70°C. but that on removing the specimen from the sludge, allowing it to warm up in the air, a small preliminary decrease and then a very sharp increase in hardness occurred. It is evident that the decomposition of the β phase was suppressed by maintaining it at -70°C.

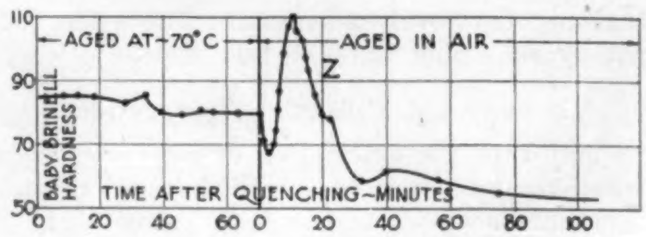

Fig. 11. Time-hardness curve for specimen Z showing how the decomposition of the β phase is suppressed by aging at a temperature of -70°C., and how it takes place very rapidly on subsequent aging at room temperature.

b. *Dilatometric Examination*—To confirm the conclusion that the decomposition of the β phase is retarded at the lower aging temperatures, a specimen containing 77.6% Zn, designated as Z1 (analogous to Z, Table 2) was heated to 400°C., quenched in ice water and examined dilatometrically at aging temperatures of 0°C. and -190°C. Fig. 12, which is typical of numerous runs of this kind, shows the contraction and hardness of the alloy aged at 0°C. It is evident that most of the shrinkage had occurred by the time maximum hardness was attained. When placed in liquid air in the dilatometer vessel (-190°C.), the specimen contracted, but this shrinkage could be attributed to the temperature change from 0°C. to -190°C. On allowing the specimen to return to room temperature, the typical contraction took place, which indicated that the decomposition of the β phase had not occurred at -190°C.

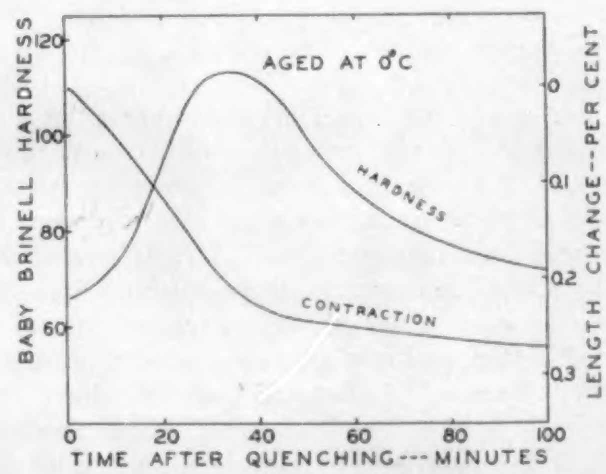

Fig. 12. Time hardness and contraction curves for specimen Z1 (77.6% Zn) aged in ice water.

The contraction of specimen Z1, quenched in ice water and aged at 100°C. was so rapid that the reaction was

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†Continued from May, 1934 issue.

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**Publication Approved by the Director of the Bureau of Standards of the U. S. Department of Commerce.

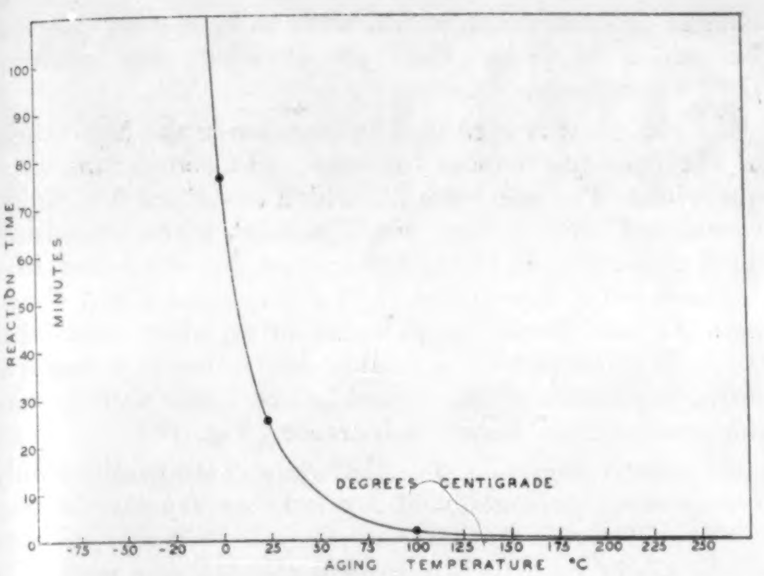

Fig. 13. Curve showing the effect of aging temperature on the speed with which the β phase decomposes. The "reaction time" ordinates were taken to be 80% of the total time required for the β phase alloy (Specimen Z1) to contract to its stable, more dense form.

practically complete within 3 minutes after quenching. Fig. 13 shows how the aging temperature affects the speed of the decomposition of the β phase. Since in all cases most of the shrinkage occurred during the first part of the aging period, the co-ordinates representing the "reaction time" were taken as the time required after quenching for the specimen to contract 80% of the total measured volume change. Fig. 13 also indicates that at aging temperatures below about -20°C. no decomposition occurs. The curve extended cuts the zero time axis between 250° and 260°C., thus showing that an aging temperature just below about 250°C. would cause the decomposition to take place practically instantaneously. Above 256°C. (Fig. 1), of course, no change would occur since the face-centered cubic lattice of the β phase is stable above this temperature.

2. *Effect of Addition of Magnesium*—One β alloy studied by Hanson and Gayler[4] (80.1% Zn), showed a maximum increase in hardness attained some 50 minutes after quenching and aging in ice water, while about 35 minutes were required for specimen Z in the present work (78.3% Zn) under similar conditions (Fig. 10). Hanson and Gayler's alloys were made from materials containing 0.34% total impurities, whereas the metals used in this investigation contained 0.02% total impurities. The remarkable effect which small amounts of other metals produce in retarding the rate of age-hardening has been studied by Pierce and Brauer[9] in relation to Zn-base die-casting alloys. Cu, Mg and other metals have been added to Zn-Al alloys in the β range of composition to stabilize them. In the present investigation, the effect of additions of Mg was studied.

A series of alloys was made and homogenized in the manner previously described. Their compositions are shown in Table 3.

Table 3. Composition of Alloys, 2nd Series

Specimen Designation	% Zn	% Al	% Mg	Remarks
ZZ*	78.7	21.0	..	Commercial aluminum and zinc having total impurities of 0.8% were used for alloys AA and ZZ.
AA*	85.3	14.2	..	
ZZMG**	78.5	22.0	0.4	Very pure aluminum and zinc having 0.02% total impurities were used for these 5 alloys.
AAMG**	84.2	15.0	.8	
AB**	85.0	15.0	.03	
ZB**	78.1	21.9	.04	
ZC**	78.2	21.6	0.21	

*Analysis for zinc. Aluminum obtained by difference.
**Analyses for zinc and magnesium. Aluminum obtained by difference.
Analysis by W. D. Mogerman, Bureau of Standards.

Specimens ZZ and AA were made from commercial Al and Zn and the other 5 from the high purity metals previously mentioned.

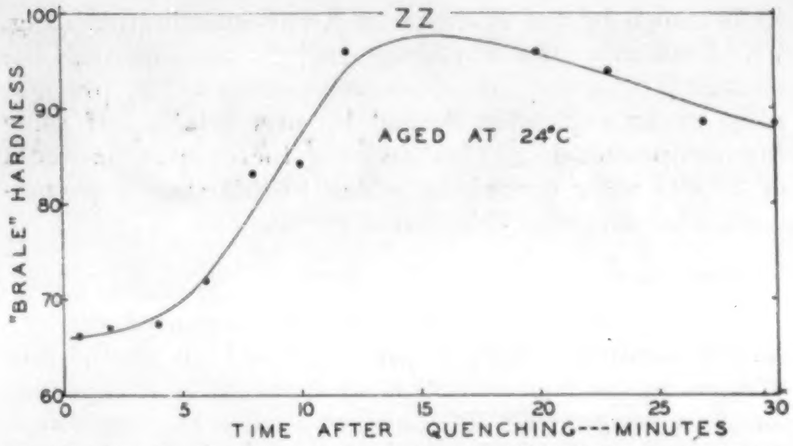

Fig. 14. Time-hardness curve for specimen ZZ (78.7% Zn) aged at room temperature.

Specimen ZZ was heated to 350°C., quenched in ice water and aged at room temperature. From the results in Fig. 14 it will be seen that the maximum hardness occurred 15 minutes after quenching, whereas in the very pure alloy of the same composition the maximum hardness occurred 6 minutes after quenching (Fig. 4). Fig. 14 also shows that the subsequent rate of softening after

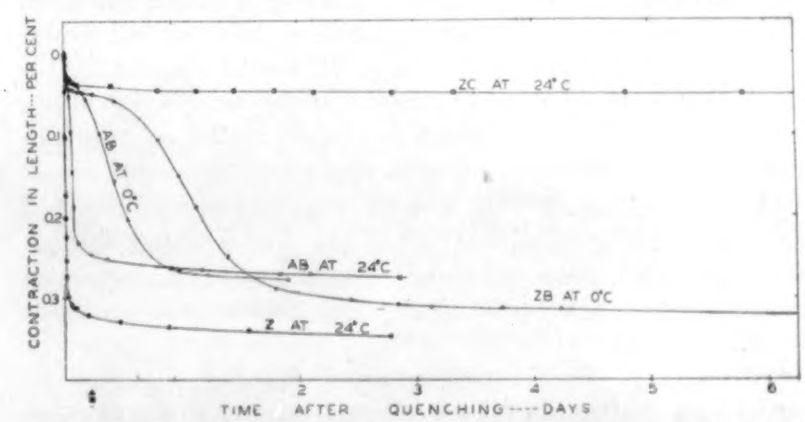

Fig. 15. Contraction curves showing how lower aging temperatures and small amounts of Mg retard the shrinkage after quenching. Specimen Z has no Mg, specimen ZB has 0.04% Mg, and specimen ZC has 0.21% Mg.

the maximum hardness had been attained was also retarded (compare also with Fig. 4).

Specimen AB was examined dilatometrically at aging temperatures of 24° and 0°C., specimen ZB at 0°C. and specimen ZC at 24°C. The results are plotted in Fig. 15 along with contraction curves for specimen Z at 24°C. The effect of additions of Mg is clearly evident.

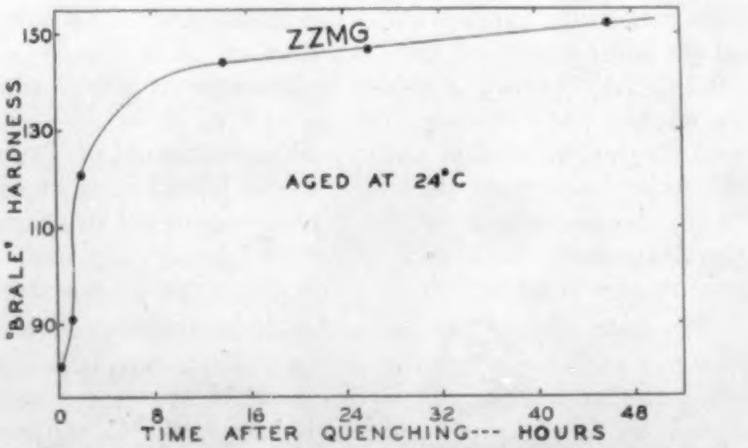

Fig. 16. Time-hardness curve for specimen ZZMG (0.4% Mg) aged at room temperature.

In the case of the alloy ZC containing 0.21% Mg the shrinkage after quenching was reduced to a very small amount. The decomposition of β phase was not suppressed, however with the addition of 0.4% Mg (ZZMG)

as is shown by the evidence of X-ray examination (Fig. 7). Evidently the shrinkage which accompanies the change $\beta \rightarrow \alpha + \gamma$ has been compensated for, presumably by an expansion caused by precipitation of some Mg compound. Fig. 16 shows the increase in hardness of ZZMG after quenching which in this case is permanent, and supports this latter conclusion.

V. Discussion

The fact that only a partial explanation of the observed hardness changes can be based on the visible changes in the microstructure is apparent on comparing the percentage gain in hardness with the estimated percentage of the β phase which had decomposed at the time the hardness was measured. Thus in Fig. 6A, an estimated percentage of less than 10 of the decomposed β phase was accompanied by an increase in hardness of 11% (expressed as a percentage of the total increase in hardness which occurred). In Fig. 6B, the decomposed β phase was estimated as 40% whereas the accompanying hardness increase was only approximately 20% and in Fig. 6C, the decomposition of the β phase estimated being 70% complete was accompanied by an increase in hardness of 39%. The rate at which the hardness increases most rapidly occurs, according to the visible microstructure, when the change in the β phase has been nearly completed, there being little or none of the unde-decomposed β phase remaining. It would appear therefore, that some factor in addition to the simple decomposition of the β phase, which is visible in the microstructure, must be considered as a contributing cause.

A comparison of Fig. 4 with Fig. 6D shows a rapid decrease in the hardness after the fine-grained duplex structure had been attained. No microscopic evidence has been brought forth to explain this softening, since the fine-grained structure is the permanent one assumed by this alloy. Most investigators heretofore have attributed such softening to coalescence of the fine particles of the duplex structure without actually being able to support this assumption by microscopic evidence. A probable cause of the sharp increase and subsequent decrease in hardness of the quenched β alloy may be found in the severe straining of the crystal lattice accompanying precipitation of the α and γ solid solutions from the preexisting β phase and in the subsequent relieving of these strains as the Al and Zn atoms migrate to positions of equilibrium in the lattice. Merica's picture[8] of this hardening mechanism seems applicable in this case.

It is interesting to note in this connection that Merica shows curves based upon Tanabe's work[7] which indicate that maximum hardness was not attained until 20 minutes after completion of the contraction of a Zn-Al alloy (9.5% Al) having a moderate amount of the β phase. In all the present experiments, and in those of Hanson and Gayler, as well as additional experiments of Tanabe, the indications were that the various phenomena incident to the decomposition of the β phase occurred practically simultaneously with each other and hence any one is a true criterion by which to study this type of reaction.

The rate of age-hardening by decomposition of the β phase is reduced when the aging temperature is lowered since the mobilities of the Zn and Al atoms are so reduced at low temperatures (below —20°C. approximately) that no dispersion takes place (see Figs. 10 and 11). In like manner, the rate of contraction of specimens containing the β phase is reduced when the aging temperature is lowered (see Fig. 15). In all cases however, the maximum hardness after quenching the β alloy is attained approximately in the same time that most of the contraction takes place. Hence, either the hardness change or contraction would seem to be a good criterion by which to judge the rate at which the reaction, $\beta \rightarrow \alpha + \gamma$, proceeds.

In Fig. 15 it is seen that an increase in the Mg content of the β alloys reduces the amount of contraction after quenching. The specimen ZC which contained 0.21% Mg contracted only a very small amount after quenching. This reduction of shrinkage cannot be attributed to a suppression of the change $\beta \rightarrow \alpha + \gamma$ since Fig. 7 shows both Al and Zn X-ray patterns in an alloy containing 0.4% Mg, but is more probably due rather to a compensating expansion of the crystal lattice which accompanies the precipitation hardness increase (Fig. 16).

In some commercial Zn-Al-Cu die casting alloys only a very small percentage of Mg is necessary for the prevention of shrinkage after casting. In the case of pure Al-Zn alloys used in this work 0.2% Mg was needed to eliminate shrinkage. Evidently the presence of Cu and/or other alloying elements in the die casting alloys also aids in preventing the shrinkage. The behavior of the alloys made from commercially pure Al and Zn supports this assumption. Probably 0.1% Mg in pure Al-Zn alloys of the β composition would have an effect intermediate between the effect found for 0.04% and for 0.21% Mg (Fig. 15).*

Although the present work has not been carried far enough to throw much light on the purpose in mind when the work was undertaken, that is the mechanism of decomposition of unstable phases, it has contributed to our knowledge of the important effects which may result from the presence of small amounts of "additions" in an alloy.

VI. Summary

1. This investigation has consisted largely in the examination and cataloging of the properties of the unstable β phase of the Al-Zn alloy system.

2. An evolution of heat, a contraction, and a temporary increase in hardness accompany the decomposition of the β phase into a finely divided mixture of α and γ solid solutions.

3. The results agree, in general, with those of previous investigators except that the velocity of decomposition of the β phase has been found to be dependent upon the purity of the constituent metals used in preparing the alloy. With materials of very high purity such as were used in the present investigation, the rate of reaction was found decidedly faster than with materials of commercial grade.

4. Methods for retarding the decomposition have been studied. Two appear most effective, namely, lowering of the aging temperature, and additions of small amounts of alloying elements, principally magnesium. The first method merely inhibits the reaction while the alloy is maintained at the low temperature. The second method, the addition of Mg, does not prevent the change from the face-centered cubic lattice of the β phase to the mixture of hexagonal and face-centered cubic lattices of the α and γ solid solutions although it does aid in compensating for the contraction which normally accompanies this change.

VII. Acknowledgments

The author wishes to express appreciation to Peter Hidnert of the Bureau of Standards for valuable suggestions and assistance as well as to K. A. Milliken and H. S. Krider for assistance in the investigation.

*Mr. H. A. Anderson pointed out, in a personal communication, that the commercial die casting alloys contain only 4% Al or 7% Al + Cu, and thus contain so little of the β constituent that far less Mg should be required to control the shrinkage than in alloys containing 14 to 22% Al.

FURNACES

for Elevated Temperature Tests

by H. Montgomery* and J. W. Bolton**

THE PRIMARY PURPOSE of this paper is to describe a type of furnace construction offering considerable flexibility in adjustment of local temperatures. Some comment on certain pertinent factors in elevated temperature creep and short time testing also is included.

In "creep" testing the fundamental requirements are that accuracy must be maintained in loading, extension measurement, and temperature control. Ease of attaining proper accuracy probably is greatest in loading and least in temperature control.

The recent tentative code for creep and short time testing advanced by the Joint Committee on Effect of Temperature on the Properties of Metals of the A.S.T.M.-A.S.M.E. requires calibration indicating maximum temperature variation over the test specimen gage length of 5°F. for "creep" tests and 10°F. for "short time" tests, for temperatures up to 1200°F. and somewhat greater tolerances above this temperature. The control calibration covers 6 points, 3 along the outside of the bar (center and shoulders) and 3 along the central axis.

In the creep test the only property measured is elongation over the gage length at constant loading and at constant temperature. This property as determined over long periods of time apparently is more affected by minor variations in temperature along the gage length than are the properties of yield strength and ultimate strength as determined on short time high temperature tests, this accounting for the greater temperature tolerances allowed for the short time tests. In these latter the elongation and reduction of area are measured after fracture and the refinements required to show small rates of creep "elongation" are neither possible or required. While for a given set of conditions it is possible to attain uniformity of temperature over the gage length in furnaces in which the winding characteristics cannot be readily altered, the furnace described herein is designed to permit great flexibility in this respect.

As shown in Fig. 1 the heating element of the creep test furnace consists of No. 16 Nichrome wire on a threaded alundum tube, gap wound in the central portion as is indicated. The rest of the wiring is uniform. The wiring is continuous. The winding is "looped" and bent in such manner that taps from every 5 coils are led to the exterior of the furnace, permitting shorting out or insertion of resistances in parallel, as may be required. This loop construction is shown in Fig. 2. The loops are fastened at the bases and flattened out, being carried to the exterior through single hole porcelain insulators. No trouble has been encountered with arcing.

The overall length of the furnace is 14¼ inches. Up to 1000° F. or somewhat above we have found that silver sheet is the best lining for the alundum tube. Nickel plated copper sheet oxidizes too readily to be satisfactory. We understand, however, that copper with nickel and chromium plate does well. While our tests on this type furnace have not been run beyond 1200°F. there appears to be no good reason why the alundum tube without metallic lining should not be satisfactory up to the useful limit of the Nichrome winding. The tube is sturdy and the winding can be put on quite uniformly by threading the tube as mentioned. The tube is surrounded by closely packed "Silocel," leads to the exterior being protected by porcelain tubes. The exterior is covered with a sheet iron jacket with steel bushings on the ends. An aperture through one side

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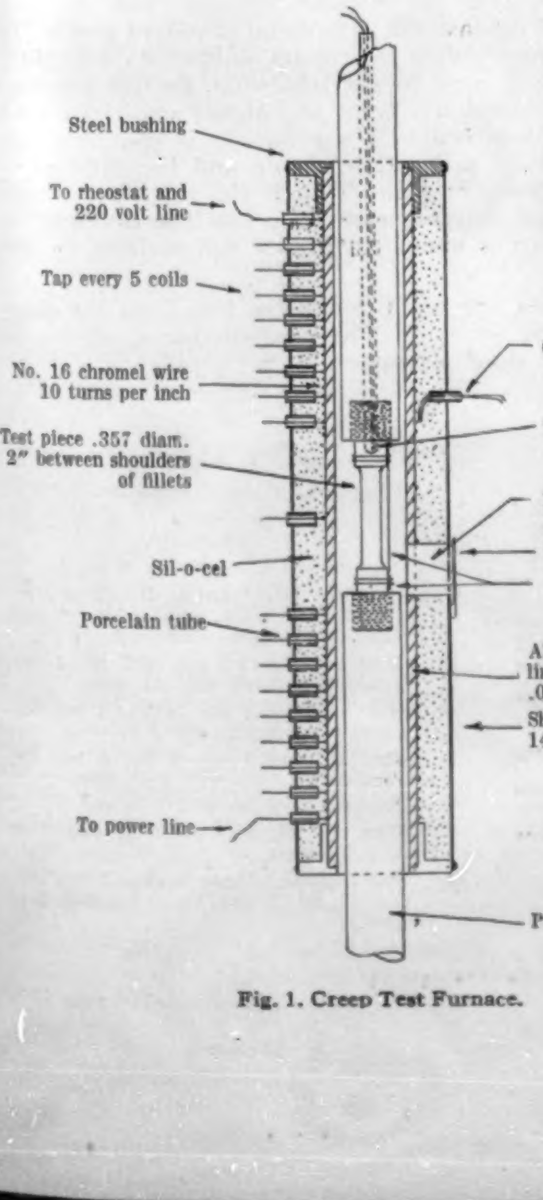


Fig. 1. Creep Test Furnace.

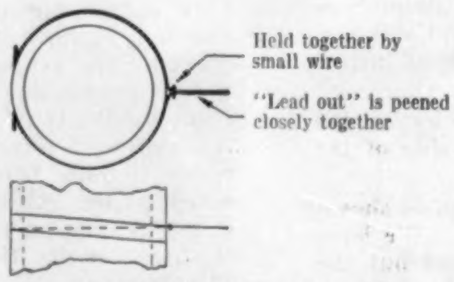


Fig. 2. Method of making tap with wire continuous.

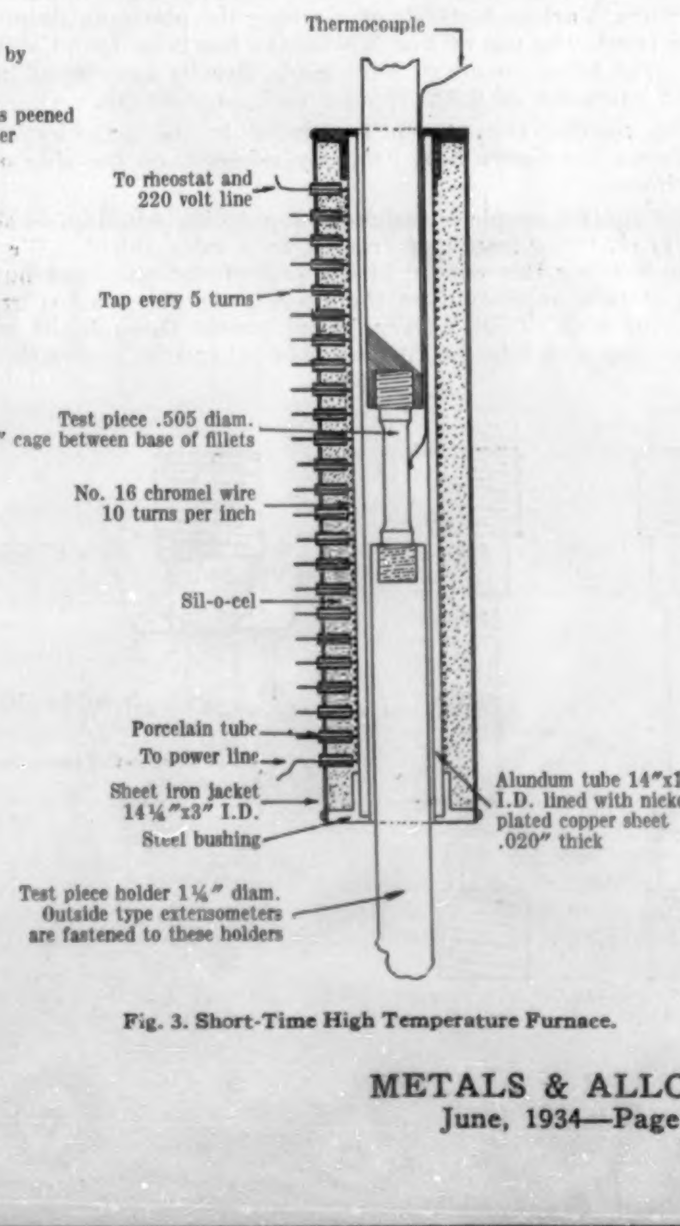


Fig. 3. Short-Time High Temperature Furnace.

of the furnace is provided so that the platinum strips can be seen. This is covered by a thin carefully ground and polished window of clear fused silica which is slipped into a slide. The construction for a short time furnace is shown in Fig. 3.

This flexible type furnace construction was adopted by the research laboratory division of the Lunkenheimer Co. after several years experience with the conventional fixed winding furnaces. While good uniformity can be attained in such furnaces by empirically winding and rewinding, it is our experience that a furnace which gives excellent results on one type of material at one temperature rarely is satisfactory for other materials or other temperatures. Great care has been used in construction of such furnaces, both of our own designs and copies of others described in the literature. Our only objection to such furnaces is based upon their inflexibility and the nuisance and bother of rewinding them.

To mean anything from an engineering viewpoint, temperature readings should be accurate from an absolute as well as a relative viewpoint. In the calibration of couples used in our furnaces these are compared directly to a Bureau of Standards calibrated and certified rare metal couple. This in turn is checked occasionally against Bureau of Standards pure metals used for melting point determinations. E.M.F. is measured on a L&N double range precision potentiometer, readable directly to .003 m.v. on the low scale and to 0.015 m.v. on the high scale. (This reads directly to about 0.5°F. on chromel-alumel couples.) Furnace couples are directly checked before and after running on test. Each and every couple is checked against the standard couple, rather than making spot checks on a lot of wire. While no serious changes have been noted it is our practice to discard couples that have been run on long tests. Incidentally for a given temperature some of the base metal couples do not generate the e.m.f. required by theory, differences of several degrees having been found. This is easily compensated for.

While every precaution is taken to get absolute temperature readings conservative judgment suggests that some slight error may be involved. For example, the absolute readings on the Bureau of Standards couple are certified only within a maximum range of ±2°C. (or a spread of 7°F.) in the range 265° to 1100°C. (2012°F.). Within the range 700° to 1200°F. it is probable that the accuracy is somewhat closer, say a spread of 2° or 3°F. Within the limits of our calibration methods we usually check the Bureau of Standards pure zinc within about 2°F. (at 787.1°F.) or 3°F. on pure aluminum (at 1220.3°F.).

Extension is measured by means of a telescope with micrometer screw, such as is commonly employed in this sort of work. As shown in the drawing (Fig. 1) a short platinum strip is fastened to the lower shoulder of the specimen and a long one to the upper shoulder. These strips nearly meet opposite the aperture. Various methods of marking the platinum strips have been tried. The use of fine XX marks has been found satisfactory. The telescope micrometer reads directly to 0.000042 inches, or an extension of 0.0021% on 2 inch gage length.

The reading couple can be placed in the shoulder of the specimen (as shown) or, properly shielded, on the side of the specimen.

The control couple is fastened close to the winding, as shown in Fig. 1, being insulated from it by a mica shield. (We have tried locating this couple in the end of the specimen but the temperature oscillation on the reading couple was too great.)

About 90% of the current input passes through the coarse resistances and into the furnace. The other 10% passes through the controller and the fine adjustment rheostats. Using the hookup we find that the recording couple temperature usually shows as a straight line on the automatic time-temperature recorder chart. That is, for considerable periods the control uniformity is within the sensitivity of the recording device. Over long periods some "drift" occasionally occurs. When this becomes appreciable current adjustment is made.

Furnaces and controllers are in a room, the temperature of which is thermostatically controlled to ±2½°F. at any given location. The desirability of keeping room temperature constant is most obvious. Electric heating units with thermostat control are used for this purpose.

Six machines employ the lever principle of loading and two are dead load. The lever type machines are check calibrated for both low and high loads. Provision is made to obtain axial loading. (Other laboratories that read on both sides of their specimens find that secondary flow is not affected by slight departures from pure axial loading.)

The proof of the utility of this type of furnace rests on the results obtainable in actual practice. After preliminary trials, 8 creep test furnaces and one short time furnace were made up. Naturally, these were constructed to give as uniform characteristics as possible, following the procedures used in construction of less flexible types. We never have had the least trouble getting calibrations within the requirements of the code, using shorts and external resistances. As constructed without using any auxiliary devices the furnaces will be within 10° to 15°F. over the gage length for most conditions, and in some cases considerably closer.

Using external shorts and resistances the uniformity attainable apparently is limited only by the accuracy and sensitivity of the temperature measurements and by the conductivity of the test specimen.

Fig. 4 shows the location of couples in the calibration bar. Three are on the outside. They are shielded and held tightly to the specimen. Three others are within the bar on the central axis. The seventh is within the bar above the gage length. Fig. 5 shows a calibration of a 5% chromium molybdenum steel bar. Four trials were made before this adjustment was reached—two being checked per day, or two days to get the final adjustment.

In this particular calibration the maximum variation is 2.5° F. over all points. The maximum variation over the gage length is 1°F. on the outside, 0.5°F. on the inside. While we have had calibrations within 0.5°F. both on the outside and inside along the gage length, we so far have been unable to get closer than 2°F. overall spread because of the variation between outside and inside. The chromium molybdenum steel used in the calibration shown apparently is not quite as good a conductor as some steels, hence is a good one for a tryout.

In calibrating couples for regular furnace readings each couple is calibrated against the rare metal standard couple. In checking the reference points in furnace uniformity a slightly different procedure is used to get somewhat greater freedom from possibility of cumulative error and higher sensitivity also. A calibrated reference couple (base metal) is compared directly to each furnace calibration couple and the differences noted on the galvanometer scale. That is the reference couple is set to zero on the galvanometer scale and the differentials read. Sensitivity then is about 0.3°F. per full division on the galvanometer.

The center couples are put through the bar from the sides rather than through the ends. The construction is shown in Fig. 6. This avoids dead air space.

Fig. 4

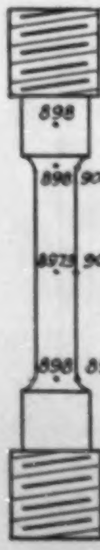


Fig. 5

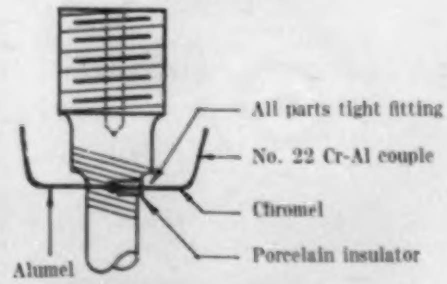
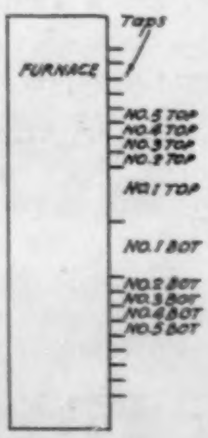


Fig. 6. Method of inserting center line couples.



FURNACE	CORRECTION
1	Short out No. 3 top to No. 3 bot. inc.
2	Short out No. 2 top to No. 2 bot. inc. Parallel No. 3 bot. with .67 ohms resistance.
3	Short out No. 2-3 bot. and No. 2 top. Parallel No. 3 top with .31 ohms.
4	Short out No. 2 top to No. 2 bot. inc. Parallel No. 3 bot. with 2.17 ohms.
5	Short out No. 3 top to No. 3 bot. inc. Parallel No. 4 top with 1.91 ohms.
6	Parallel No. 2 top with 1.63 ohms.
7	Short out No. 2 top. Parallel No. 3 top with .64 ohms.
8	Short out No. 1 top to No. 2 bot. inc. Parallel No. 2 and No. 3 top with 1.84 ohms.

Fig. 7. Furnace Calibration.

(Continued on page 130)

Effect of Notches on Nitrided Steel*

by J. B. Johnson† and T. T. Oberg‡

AIRCRAFT engine parts, such as gears, couplings and accessory drive shafts may be made either from oil hardened steels such as S.A.E. 3250 and 6150, or case hardened steels, S.A.E. 3312, 2512, and Nitralloy. The duplex structure of the case hardened steels gives excellent resistance to bending and torsional stresses, and to flow and abrasion under high pressure. The present trend in design is towards the replacement of the oil hardening steels by the duplex type. For the most severe service conditions nitriding appears to be superior to carburizing.

The new Boeing Wasp-powered, twin engine transport plane of United Air Lines.

Fatigue is always an important consideration as a large percentage of the failures of aircraft engine parts are of this nature. Several investigators have published data showing the relatively high fatigue limits of the duplex structure.[1,2]

Inspectors of aircraft engine parts are familiar with the detrimental effect of sharp corners and surface defects in parts manufactured from hardened steels. The natural assumption has been that defects in the very hard case of nitrided steel would be still more detrimental. The designer has also raised the question as to whether it was necessary to allow more liberal fillets in nitrided steel than in the oil hardening steels. The tests reported herein were made in order to throw some light on these questions.

The tests were made on specimens machined from $\frac{13}{16}$ inch bars of Nitralloy "G" steel. The tests were made on the R. R. Moore rotating beam machine using the standard specimen except that the notched specimens had no taper in the middle. The specimens were rough machined within $\frac{1}{8}$ inch of the finished dimensions before heat treatment and subsequently ground and polished. The specimens were nitrided in a Homo furnace for 48 hours at 950°F. Some of the specimens were notched and nitrided and others were nitrided and then notched. The notches were circular grooves cut with a 24 pitch standard threading tool in the softer material and ground with a formed wheel in the nitrided specimens. The notches were compared as to form and dimensions on a Zeiss Universal Measuring Machine. The notch shown in Fig. 1 is typical.

The chemical composition and physical properties of the steel are indicated in Table 1. The lower curve in Fig. 2 indicates the variation of Vickers hardness number with depth of case. The hardness block was treated with the fatigue specimens after which one surface was ground with a taper of $1\frac{1}{2}$°. The results of fatigue tests are shown in Figs. 2 and 3. The results obtained on the material nitrided after cutting the notch agree with those reported recently by Mailänder.[3] The V-notch did not reduce the fatigue limit of the specimens nitrided after cutting the notch as the fatigue curves for notched and unnotched specimens drawn at 1200°F. are practically superimposed, Fig. 3. The V-notch in the unnitrided steel caused a reduction of 30% (Table 1). The fatigue strength of the unnotched nitrided specimens was increased about 6% with an increase of 10% in the tensile strength of the core material when the drawing temperature was reduced from 1200° to 950°. The fractures of the fatigue specimens invariably started at some point below the surface, Fig. 4.

Fig. 1. Circular Groove, 60° included angle, 0.008" radius at bottom.

Table 1. Chemical Composition and Physical Properties

Chemical Composition: Carbon 0.35; Chromium 1.50; Molybdenum 0.20; Manganese 0.50; and Aluminum 1.25

	Heat 1750°F., quench in oil, draw 1200°F. for 1 hr.		Heat 1750°F., quench in oil, draw 950°F. for 1 hr.	
Heat treatment	Not nitrided	Nitrided 950°F. 48 hrs.	Not nitrided Redrawn at 950°F. 48 hrs.	Nitrided 950°F. 48 hrs.
Tensile strength	149,000	141,400	165,000	165,000
Yield strength set .002 in/inch	..	..	147,000	140,000
Elongation* %	16	..	15	4
Reduction of Area %	..	..	50	..
Vickers hardness	288-295	974-1000	357-369	1003-1064
Fatigue limit (Unnotched)	61,000	82,000	..	87,000
Fatigue limit (Notched)	43,000	82,000	..	..

*Gage length = 4 × diameter.

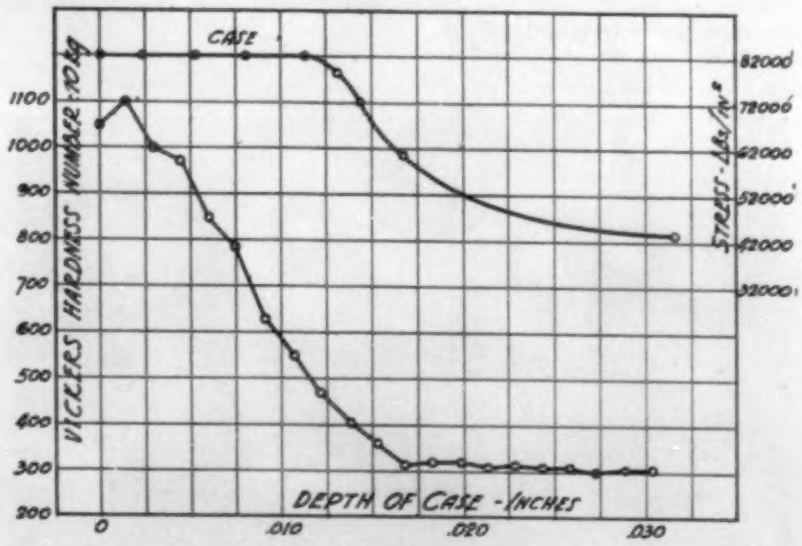


Fig. 2.

*Published by permission of Chief of Air Corps, U. S. Army.

†Chief, Material Branch, Wright Field, Dayton, Ohio.

‡Material Testing Engineer, Wright Field, Dayton, Ohio.

[1]H. F. Moore & N. J. Alleman. Fatigue Tests of Carburized Steel. *Transactions American Society for Steel Treating*, Vol. 13, 1928, pages 405-417.

[2]N. L. Mochel. A Note on the Fatigue Tests of Nitrided Steel. *Proceedings American Society for Testing Materials*, Vol. 30, Part II, 1930, pages 406-410.

[3]R. Mailänder. Ueber die Dauerfestigkeit von nitrierten Proben. *Zeitschrift Verein deutscher Ingenieure*, Vol. 77, 1933, pages 271-274.

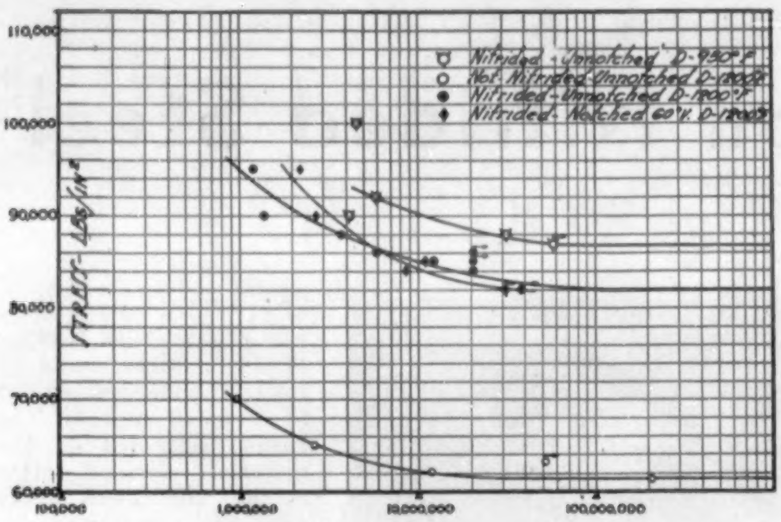


Fig. 3. Number of cycles of stress for rupture.

Table 2. Fatigue Tests of Nitrided Specimens
(Notch Cut after Nitriding)

Depth of Notch	Stress	Cycles
None	86,000	8,730,300 F
None	82,000	61,500,000 NF
.0012	86,000	3,084,000 F
.0023	82,000	36,500,000 NF
.0053	82,000	20,100,000 NF
.0080	82,000	51,000,000 NF
.0113	82,000	62,000,000 NF
.0144	82,000	90,300 F
.0140	75,000	405,600 F
.0144	72,000	10,435,500 NF
.0134	75,000	10,000,000 NF
.0170	60,000	10,005,600 NF

F—Failed.
NF—Test stopped—no failure.

The effect of scratches on the nitrided case is indicated by the upper curve in Fig. 2, plotted from results in Table 2. The specimens retained the original fatigue strength of 82,000 lbs./in.² for the smooth specimen until the depth of notch was equal to about 70% of the depth of the case, or a total of 0.012". The decrease in fatigue strength from this point with increasing depth of notch was gradual until the fatigue strength of the core material was reached. The dotted line indicates an extrapolation of the curve to the point 43,000 lbs./in.² represented by the fatigue limit of the core material containing a notch of similar proportions.

The results indicate that a hard case does not necessarily make the material more susceptible to notch effect. A comparison with published results of tests on notched specimens of oil hardening steels indicates that the nitrided steel is superior in its resistance to notch effect.

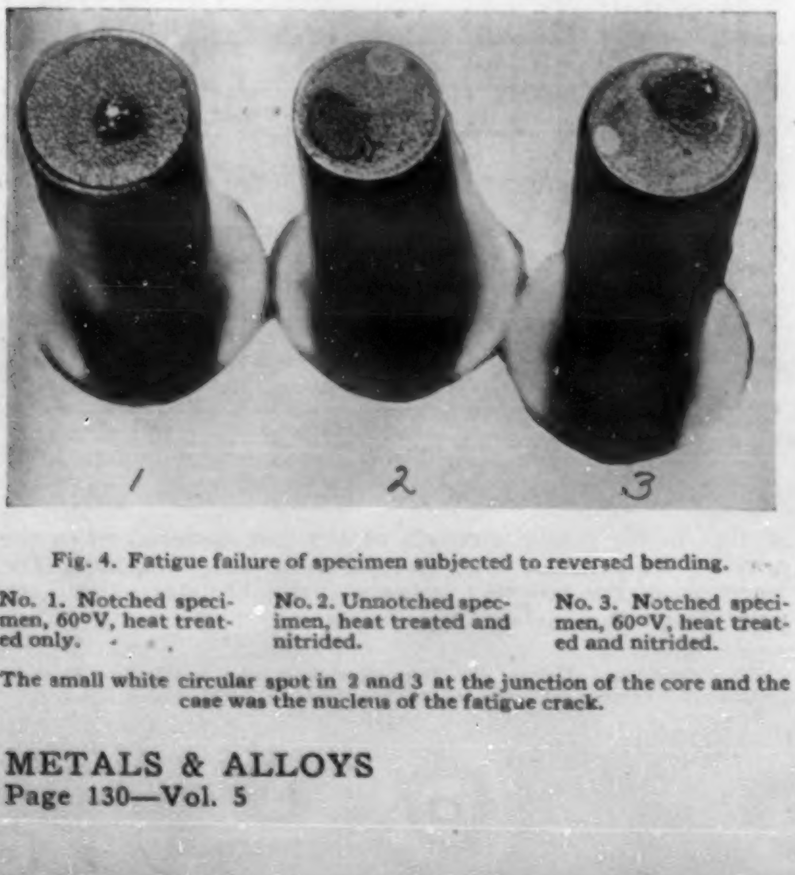


Fig. 4. Fatigue failure of specimen subjected to reversed bending.

No. 1. Notched specimen, 60°V, heat treated only.

No. 2. Unnotched specimen, heat treated and nitrided.

No. 3. Notched specimen, 60°V, heat treated and nitrided.

The small white circular spot in 2 and 3 at the junction of the core and the case was the nucleus of the fatigue crack.

Furnaces for Elevated Temperature Tests

(Continued from page 128)

While it is easy enough to get each furnace adjusted for even calibration, the different furnaces have to be adjusted individually. Table (Fig. 7) shows auxiliary shorts and resistances needed to bring the eight creep test furnaces into proper calibration for a run. No. 1 was run at 850°, 2 and 4 at 900°, 3, 5 and 6 at 975°F. and 7 and 8 at 1100°F.

Other tests have shown that the same furnace used at a different temperature, usually has to be adjusted for that particular condition.

Temperature calibrations of the short time furnace have shown that the type illustrated in Fig. 3 can be brought within the variations noted in calibration of the creep testing furnaces. Gap winding with this type furnace is not necessary. It will be noted that with this type of furnace external extensometric devices must be used. Introduction of internal extensometers which require "legs" to carry the extensions to outside reading devices constitute heat drains and close temperature uniformity probably is more difficult to attain. However, the flexibility of this sort of furnace should facilitate uniformity control.

Summary

Furnace constructions embodying means for localized temperature control are described. Variations within and without the bar over the gage length well within the code tolerances for the calibration bar are readily attained by simple adjustments. A difference of about 2°F. exists between inside and outside points. Along the central axis or along the outside gage length differences within 0.5° to 2°F. can be attained without great difficulty.

When all sources of error, cumulative at times, are considered, variations beyond those noted in a regular calibration may be introduced in a long time test. This probability is being investigated.

The writers thank The Lunkenheimer Co. for permission to publish this paper.

Seth H. Taylor, Jr., has been appointed Pacific Coast Manager for The Lincoln Electric Company, Cleveland, Ohio. Mr. Taylor will make his headquarters at San Francisco. For the last 4 years Mr. Taylor has been in charge of the Los Angeles office of The Lincoln Electric Company. Since his graduation from Western University, Mr. Taylor has been constantly active in one branch or another of the arc welding industry. He has the distinction of being partly responsible for one of the first arc welded office buildings ever to be erected. He has been engaged in the job welding business. He has devoted not a little time to the study of automatic arc welding, having been employed by several large companies in that capacity.

The appointment of **Dr. Bruce W. Gonser** as a member of the technical staff of Battelle Memorial Institute was announced by Mr. Clyde E. Williams, director of the Institute. Dr. Gonser was graduated from Purdue University in chemical engineering, received his master's degree from the University of Utah, and his doctor's degree in metallurgy from Harvard University. His wide experience in non-ferrous metallurgy particularly fits him for work on the Institute's recently announced research program sponsored by the International Tin Research & Development Council of London, England.

G. E. Alderson and **William C. Yenger** have joined the organization of the Rochester Smelting & Refining Co., Inc. Mr. Alderson, for the past 13 years, was assistant general superintendent and metallurgical engineer with Federated Metals Corporation, Duquesne Reduction Branch at Pittsburgh, Pa., and in charge of brass ingot and red metal manufacture. Mr. Yenger, for the past 2 years, was connected with the Michigan Smelting & Refining Co., and for 7 years prior to that was with H. Kramer & Co. He will act as eastern sales agent for the Rochester Smelting & Refining Co., Inc., with headquarters in New York City.

A striking example of the antiquity of some of the machine tools in active use was brought out in connection with an order received by the Warner & Swasey Co., machine tool and precision instrument builders, Cleveland. The mail brought a request for a part of a 14-inch turret lathe. Correspondence showed that the serial number was missing but a detailed description of the lathe was given. Identification was finally made from old drawings in the files; the lathe was made in about 1900 and is now well over 30 years old.

INTERNAL STRESSES

Part One of a Correlated Abstract in Five Parts by Charles S. Barrett†

Warping, cracking (season cracks, hardening cracks, grinding cracks) fatigue failure and corrosion are matters which concern every machine shop, every heat-treater, all engineers who design machines and structures of metals and alloys in which these defects may appear, and all metallurgists who process those metals and alloys. While we do know, roughly, that internal stresses produce or favor these troubles and talk very glibly about internal stresses, when we get down to brass tacks and critically survey the status of exact knowledge upon them, as is done in this correlated abstract, it becomes clear that real knowledge is very limited.

If one reads only one article on the subject at a time, particularly one of those dealing with x-ray methods for appraisal of internal stress, all seems to be lovely, for each author is usually pretty well convinced that the specific method he is advocating works smoothly and really measures the stress. But when one compares all the available data it appears that the general validity of the methods is quite doubtful.

Thousands upon thousands of man-hours have been put upon the problem by experts and so far the clearest fact that emerges is that whether one seeks to measure microscopic stresses by x-ray methods or macroscopic ones by mechanical methods, painstaking and tedious precision will be required for real accuracy.

While the search for methods takes the investigator into rather deep waters of theory, the practical need for reliable, quantitative methods of measurement is pressing. The essential preliminary to effective progress in such a field is to stand back and find out what we do know, where it seems to be leading us, and what are the most promising angles for further attack, as Dr. Barrett has done here. Pending a complete quantitative solution, some of the rougher methods mentioned are decidedly useful for throwing light on the practical problems in which internal stresses are concerned.

Whenever a metal is plastically deformed, whether by bending, rolling, forging, pressing, drawing, by a phase transformation or precipitation from solid solution, or by a severe temperature gradient, it is left in a state of strain. The strains resulting from such operations and remaining when all external forces are removed are known as internal strains, and the accompanying stresses as internal stresses (sometimes as residual or inherent stresses).* The importance of these to engineers, metallurgists and physicists lies in their marked effects on nearly all the physical properties of metals. They are directly responsible for season cracking, for quenching cracks and grinding cracks, for warping during machining, and for failure at abnormally small loads. On the other hand, they may be put to useful service in the manufacture of big guns, high speed turbine wheels and other highly stressed parts, and, of course, they are always introduced when a metal is cold worked to improve its physical properties.

Many ingenious methods have been developed in recent years to reveal and measure these internal stresses. The most direct of these are mechanical in nature and have been based upon the fact that an internally stressed body will warp, expand, or contract when layers are removed. These methods are able to reveal the stresses (sometimes referred to as Heyn's stresses) which are distributed macroscopically and which are balanced against each other over rather large regions of the stressed body. Internal stresses may also be localized and in equilibrium over microscopic regions of the body, often within a portion of a single grain. These microscopic stresses are not revealed by the mechanical methods just mentioned; they have been studied by other devices, principally by X-ray diffraction.

This correlated abstract covers the various mechanical, X-ray, and other methods of measuring internal stresses (there are now 15 or 20 of these available) and the results obtained by them. The review is critical; particular attention is paid to the errors and limitations of each method and to the uncertainties in the interpretation of results.

MECHANICAL METHODS OF ANALYSIS

Most of the mechanical methods for the measurement of internal stresses and the determination of their distribution fall into two general classes: (1) those in which a measurement is made of the change in dimensions of a body when material is removed from its outer or inner surface, and (2) those in which a measurement is made of the amount of bending of a strip when it is cut from an object. All the methods belonging under these two classifications are concerned only with macroscopic stresses and do not reveal the microscopic ones.

1. Methods involving changes in dimensions

Methods of this class were first developed for rods and cylinders by assuming the presence of only radial and tangential stresses or assuming only longitudinal stresses. Subsequently the problem was solved for the three dimensional state of stress, with simultaneous radial, tangential and longitudinal stresses.

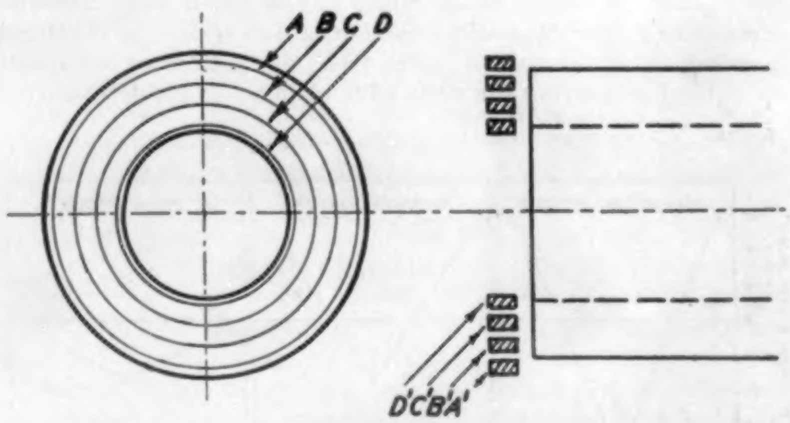


Fig. 1. An early method of internal stress analysis.

Under the assumption that longitudinal stresses are negligible, determinations of radial and tangential stress distributions in cylinders have been made by Kalakuzky,[1] Klein,[2] Macrae,[3] and others by the device of turning out rings from the cylinders. The usual procedure consists in scribing a number of concentric circles A, B, C, D, Fig. 1, on the end of a cylinder and measuring the diameter of these circles with a comparator, then cutting thin concentric rings from the end of the cylinder so that each ring contains on its end face one of the previously scribed and measured circles, as shown at A', B', C', D', Fig. 1. The release of these rings is accompanied by an increase in their diameter if the rings have come from a portion of the cylinder wall which originally contained compressive tangential stresses, and a shrinkage in diameter if the original stress was tensional. The application of the elastic theory formulas to the measured changes in the scribed circle diameters enables a calculation to be made of the magnitudes of the radial and tangential stresses under the assumption of negligible longitudinal stresses. This method has seen considerable use in the

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†Metals Research Laboratory, Carnegie Institute of Technology.

*In the German literature they appear under the terms: *Eigenspannungen, Innerenspannungen, verborgen elastischer Spannungen, Reckspannungen, Restspannungen,* or *Nachspannungen;* when of thermal origin, *Wärmespannungen;* when originating in hardening, *Härtespannungen.*

study of residual stresses in gun barrels. On the whole, however, calculations of residual stresses, based on elastic theory and measured stress-strain curves, have been more extensively used than actual stress measurements in gun manufacture. The details of such calculations need not be covered in this review. (For an extensive treatise on this phase of the subject see Macrae.[3])

The first of the methods of obtaining internal stress distribution by change of dimensions upon the removal of successive layers was worked out by Heyn and Bauer[4] and independently, but less completely, in this country by Howard.[5] It is based on the assumption of the absence of all stresses except longitudinal ones, i.e., those directed along the axis of the rod or tube, and makes use of the fact that when a given area is removed from the cross section of the rod (by turning off a layer of the rod in a lathe), the longitudinal stresses originally existing in that layer are annihilated. The remainder of the bar lengthens or shortens until equilibrium is again reached; if the change in length is $\frac{l - l_1}{l}$ per unit length, it must have been caused by a stress σ whose value is given by

$$\sigma = E \frac{l - l_1}{l}$$

where E is the modulus of elasticity of the material. If the cross sectional area of the layer removed is f', if the remaining sectional area of the piece is f, and if the average stress originally in the layer is σ', then in order that equilibrium be reached it must be true that

$$f'\sigma' + f\sigma = 0$$

and substituting the value of σ one obtains

$$\sigma' = E \frac{f}{f'} \frac{l_1 - l}{l}.$$

Continuing this type of analysis to the successive removal of layers, the distribution throughout the cross section is determined. The difficulties and limitations of this method are discussed later in connection with the more general method of Sachs, of which this is a special case.

Another partial solution of the problem was worked out by O. V. Greene**, who adapted the formulas for stresses in hollow cylindrical vessels to the estimation of radial and tangential stresses in hollow cylindrical specimens. His technique consisted in grinding off successive layers from the outside of his specimens, and measuring the successive changes in inside diameter to plus or minus one hundred thousandth of an inch. Longitudinal (axial) stresses were neglected, so the analysis represents another special case of the more general theory worked out independently by Sachs.

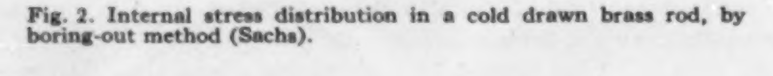

Fig. 2. Internal stress distribution in a cold drawn brass rod, by boring-out method (Sachs).

The method developed by Sachs[6] consists in boring out successive layers from the inside of a tube or from the center of a rod and measuring the resultant changes in both the length and external diameter. In the computation of stresses from these dimension changes no assumption of a special type of stress distribution is made; the distribution of each of the three principal stresses is calculated from the measurements.* An example of the type of information obtained by this method is shown in Fig. 2.

The actual formulas by which the stresses may be calculated from the dimension changes and the details of the derivation of these formulas have no place in this report, but a brief mention of the nature of the analysis is necessary. Sachs' procedure is to consider a layer of thickness $d\rho$ at the radius ρ from the axis of the specimen; he then calculates (1) the change in the stresses in this layer when all the layers with radii less than ρ are removed, and (2) the stresses destroyed when the layer itself is removed. The stresses originally present in this layer at the radius ρ are, then, the sum of items (1) and (2) above.

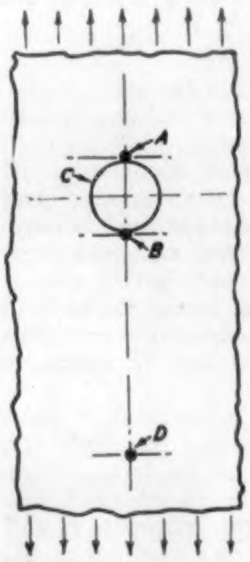

Fig. 3. Layout for stress measurement by Mather's method.

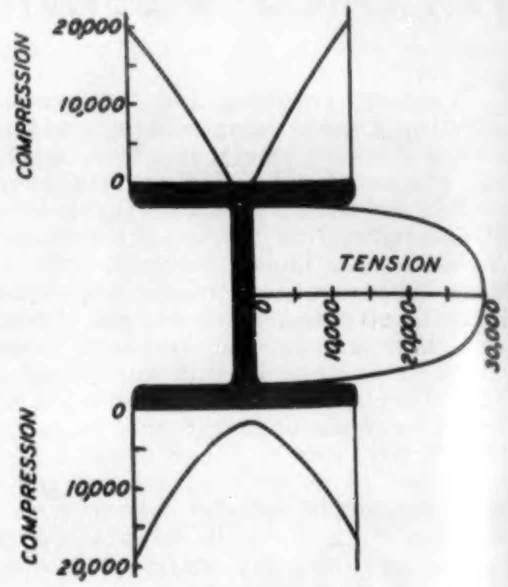

Fig. 4. Distribution of longitudinal stresses in an I-beam Mather's method.

Sachs has published an internal stress determination for a brass rod in which the longitudinal stresses were calculated to be 40% higher by his method than by Heyn's method, a significant proof of the fact that serious errors are introduced by neglecting the effect of tangential and radial stresses on the calculations for longitudinal stresses, as is done in Heyn's analysis.

Investigators have no quarrel with the mathematics of Sachs' analysis, but they regret the high precision required in the numerous measurements of the length and diameter of the specimen. All measurements must be made at constant (or known) temperatures with comparators or precision micrometers reading to 0.0001" or better, and the lathe work must be done with care to prevent overheating the specimen or producing spurious strains in it, all of which makes the technique time consuming and expensive. A further disadvantage is that the analysis is applicable only to specimens of the simplest shapes (in the original form only to round rods and tubes), in which the stress is symmetrically distributed about the axis.

A method recently worked out by Mather[7] has the unique distinction of being the only mechanical method of obtaining the distribution of internal stresses which leaves the material in suitable condition for further use, a method which can be applied, for example, to the beams in a completed bridge without seriously weakening them.

The method consists in placing a strain gage on the piece to be tested, so as to measure the distance between two points such as A and B, Fig. 3, in line with the direction of maximum stress. A hole is then drilled between these points (at C in the figure), and the resulting increase or decrease in the distance between A and B is measured on the gage. In an alternative form of the apparatus the strain gage is used between points B and D, separated about 15 cm., in which case the deformation

**The formulas used in this method have been reprinted numerous times and need not be repeated here. See, for example, O. V. Greene, *Transactions American Society for Steel Treating*, Vol. 18, 1930, page 369.

*The assumptions made by Sachs in his derivation are few: (1) the assumption of the equations for stresses in tubes under external and internal pressures which are deduced from elastic theory, and other well known elastic theory equations, (2) the assumption that the removal of a layer produces an equal change of longitudinal stress at all points on the cross section of the tube wall (a legitimate assumption when the tube diameter is small compared with its length), (3) the assumption of symmetry of form and of stress distribution about the axis of the specimen, and of constancy of stress along its length.

resulting from the drilling is only half as great as between A and B. The diameter of the hole that must be drilled is of the order of 1 cm.; it is limited on the one hand by the weakening it introduces and on the other hand by the accuracy of measurement desired. After the test is completed the hole may be closed by a rivet or plug. It is essential, of course, that the hole be drilled with such care that no deformation of neighboring material is produced, a requirement none too easily met.

The interpretation of the gage readings in terms of the intensity of internal stress is made either by reference to the mathematical theory of the strains around a hole or by carrying out a calibration experiment wherein samples of the same material are studied by the same procedure while under known stresses in a testing machine.

The above procedure applies to materials under uniaxial stresses; if the state of stress is biaxial, the direction and magnitude of the principal stresses can be determined by the aid of three measurements of the above type made at different angles. (With the strain gage and drilling apparatus designed by Mather this requires the drilling of three different holes somewhat removed from each other and the assumption that the same condition of stress holds at each of the holes.) If, however, the state of stress is the general one with three principal stresses instead of one or two, Mather's method is not applicable. The method is further limited in its present state of development to objects in which the stress is constant throughout the thickness or at least throughout about 20 mm. of the thickness. Yet if the gage readings are plotted as a function of the depth of penetration of the drill, an approximate idea may be obtained of the distribution of stresses through the thickness, though an accurate analysis of this feature of the method has not yet been worked out. Another matter which should be cleared up by further research on the method is the error introduced by drilling too close to an edge of the object.

With this method the longitudinal stresses in an I beam were successfully determined, indicating a distribution over the cross section (Fig. 4) and also over the length of the beam which was satisfactorily confirmed by some tests involving slotting and sectioning of the beam. A method closely related to this has been used by R. L. Templin of the Aluminum Company of America. Strain-gage measurements are made in various directions within a circular area on a plate and then a circular cutter is applied to the area to separate a disk. The stresses relieved by the removal of the disk are registered by the strain gage. The limitations of the method are similar to those of Mather's method.

2. Methods depending on the bending of strips

A number of men have used as an indicator of internal stress intensity the amount of springing out of a strip cut from a specimen. Each has used similar calculations; from the amount of springing out or the change in radius of curvature of the strip they have calculated the elongation of the surface fibers and the stress change in these surface fibers resulting from the bending. On this basis Hatfield and Thirkell[8] have studied internal stresses in brass tubes by turning rings from them, then cutting across the rings to let them expand to a larger diameter under the influence of the internal stresses (Fig. 5);

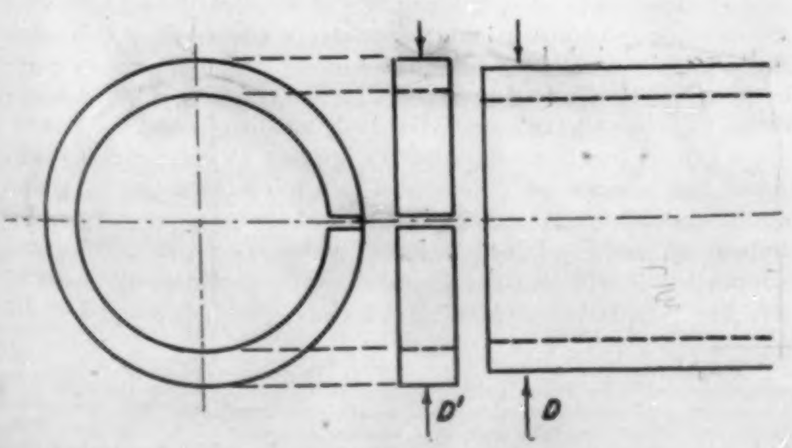

Fig. 5. Split-ring method.

Anderson and Fahlman[9] have measured the curvature of tongues cut longitudinally from the tubing to be tested (Fig. 6); Merica and Woodward[10] have measured the curvature of round rods of brass after the removal of a longitudinal section on a milling machine; Kreitz[11] and Buchholtz and Buhler[12] have measured the curvature of strips of rectangular cross section cut from round rods.

It is well recognized that stresses thus calculated are by no means accurate and dependable. This has been emphasized by Merica and Woodward,[10] by Crampton[13] (who also showed that the results obtained with strips and split rings vary greatly when the width of the rings or strips is varied), and by Fox.[14] Fox developed a modification of this method with an analysis based on the assumption that the tangential stresses in the wall of a tube are distributed in such a way that at any point they have a magnitude proportional to t^n where t is the radial distance of the point from the neutral surface in the tube wall and the exponent n may be less than, equal to, or greater than unity but remains constant throughout any one tube. He made similar assumptions about the longitudinal stress distribution. It should be noted that this assumption implies a stress distribution such that there always exists a maximum of stress at the surface, but there is ample evidence that such an assumption is frequently invalid in practice. Crampton[15] criticized the assumption of a constant value of n throughout the wall of a tube of brass, but nevertheless concluded that methods of this general type are useful for obtaining an approximate idea of stress distribution and intensity without the necessity of difficult and time-consuming measurements. He used the scheme of cutting rings from brass tubing after the tubing had been turned down to different wall thicknesses, a procedure also used by Fox, and then applied the early formulas of Hatfield and Thirkell to the change in diameter of these rings when they were cut open.

The methods that have been reviewed in this section are attempts to get approximate rather than exact information on stress distributions and intensities. While they do not require the difficult and time-consuming technique of the boring-out method of Sachs, and can be carried out with the equipment available in almost any shop, there is a rather widespread opinion that the inaccuracy of these methods is so great as to render them of little practical value in studying internal stress problems.

Buchholtz and Bühler[12] have published a striking example of the inaccuracy of the method of Kreitz; they found that maximum longitudinal stresses in steel rods as determined by the Sachs method were sometimes as much as three times as great as those determined in the same material by the bent-strip procedure of Kreitz. In view of the unsatisfactory nature of the methods just reviewed, no small importance must be attached to a paper by Dawidenkow[16] proposing a method that enjoys the ease of measurement of the tongue and split-ring methods and yet at the same time provides true stress data. Furthermore it appears to be the only accurate method available for use with tubes having walls too thin or stresses too slight to be studied by the method of Sachs.

The mechanical operations required are similar to those of the method of Fox. A number of adjacent sections of the tube to be tested are turned to various wall thicknesses. Rings are cut from these sections and split open, as in Fig. 5, and the

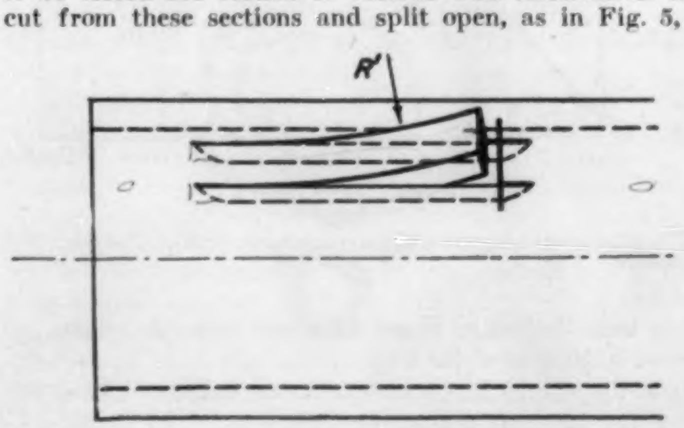

Fig. 6. Tongue method.

change in diameter, D′ — D, is measured by a suitable gage. Similar measurements are made of the curving of tongues cut out along the length of the tube as in Fig. 6. Because of the length of tubing required for this procedure, throughout which

one must assume an unvarying state of stress, Dawidenkow suggests an alternate procedure consisting of a series of curvature measurements on the same ring or tongue, between each of which measurements the wall thickness is reduced by etching one surface of the piece. But the removal of material by etching is a procedure that must be used with caution in internal strain research. Before it can be trusted under any particular conditions it is necessary to know not only that the surface is removed uniformly but also that there is no weakening of the underlying grains or grain boundaries by the acid attack.

Dawidenkow deduces the tangential stress σ at any layer in the tube wall by an analysis of its release in three steps.

1. A slot is cut in a ring which allows the ring to spring to a new diameter. This releases a stress σ_1 in the layer considered, which is calculated by applying the formulas for a bent beam.[17]

2. The etching away of the layer being considered brings about the release of a bending moment, which is calculated from the change in diameter it produces. From the formulas for a bent beam the stress σ_2 contained in the layer before it was removed is calculated.

3. The stress released in this layer by etching away all material on one side of it is then calculated. This stress, σ_3, comes about through bending, as in the cases (1) and (2) above, and also through the change in length of each of the fibers by the release of longitudinal stresses. The calculation of σ_3 involves integration of the functions giving the variation of ring diameter with wall thickness (x) and with the square of the wall thickness (x^2). These integrations are performed graphically from plots of diameter against x and against x^2 respectively.

The final result is the sum of these three stress changes:

$$\sigma = \sigma_1 + \sigma_2 + \sigma_3.$$

Dawidenkow's calculation of the longitudinal stress in any layer is closely analogous to the calculation just mentioned for the tangential stresses; he again calculates the stresses originally present as the sum of those released by cutting out the tongue, those released by removing all the material on one side of the layer considered, and those released by removing the layer itself.** No independent estimates of Dawidenkow's analysis and the accuracy obtainable with it are as yet available.

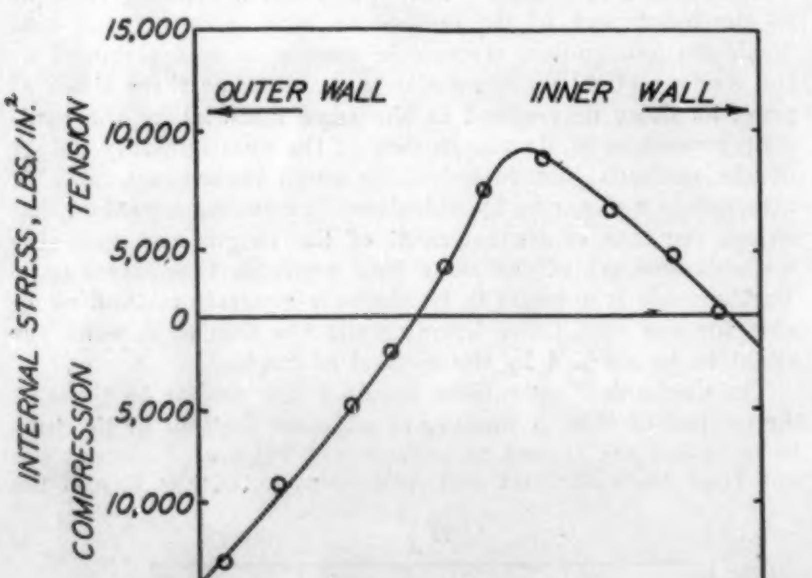

Fig. 7. Distribution of tangential stresses in a brass tube by Dawidenkow's method.

If one were to judge from the single example given by Dawidenkow, reproduced in Fig. 7, the accuracy to be expected would appear to be better than 1000 lbs./in.^{2} and quite satisfactory for internal stress research.

3. Miscellaneous methods of revealing internal stresses

Studies on the rate of relief of internal stresses by annealing have been made by a very simple procedure recently used by Mailänder[18]. It consists merely in mounting a tensile specimen in a tensile machine, surrounding the specimen with a furnace by which it may be kept at a constant elevated temperature, and continually measuring the stress that must be applied by the machine to keep the total length of the specimen a constant. As plastic flow occurs, the stress that must be applied steadily decreases at a rate which is assumed to be more or less the same as the rate at which internal stresses in a body of the same material would decrease during annealing. Obviously, this stress-time method is of value only if the correspondence is close between the rate of diminution of stress in the Mailänder procedure and the actual rate of diminution of internal stress in a body, and on this point there is a divergence of opinion. Mailänder believes the correspondence to be satisfactory, while Buchholtz and Bühler,[19] by direct comparison of curves obtained by the Mailänder scheme and those obtained by the boring-out method of Sachs, conclude that the correspondence is only a qualitative one and may be in error by a factor of two. The errors are ascribed to the fact that in the tensile specimen the stress distribution is uniaxial while in internally stressed bodies it is three dimensional, and to the fact that more plastic flow and therefore more work hardening must take place in Mailänder's case than in an internally stressed body.

Internal stresses have been revealed by the reflection of polarized light from metallurgical specimens.[20] To date, the surface reflection of polarized light has been used merely as a qualitative indication of strain, not a quantitative measure of it, and it is further limited to cubic metals; but it has the important characteristic that it discloses microscopic stresses while all the methods previously mentioned in this review are concerned only with macroscopic stresses.

A number of simple mechanical tests are available for indicating the progress of strain relief during annealing but these need only be mentioned here because of their qualitative nature. Among the most direct of these are the deflection of a strip under a given load, or the amount of springing out of a strip which has previously been bent around a mandrel and given a stress relief anneal in this position.[21] Canfield[22] has followed the recovery from the effects of cold work by measurements of internal friction.

A frequently used test for internal stresses depends on the tendency of stressed bodies to develop cracks when subjected to corrosive attack.*** The usual procedure is to immerse brass objects in baths of mercurous nitrate or other salts of mercury and note the time required for cracks to start. Similarly, acids and alkalies can be used to induce cracks in internally stressed iron and steel. Tests of this type give data rather ambiguously related to the actual distribution and intensity of internal stresses—data which are chiefly dependent on the stresses at or near the surface, and of these perhaps disclosing only the tensional ones.

The magnetic properties of ferro-magnetic material, especially under alternating current magnetization, are sensitive to all the variables affecting the mechanical properties. Elastic and plastic deformations, important among these variables, may profoundly alter the shape of the magnetic hysteresis loop. In the elastic range stress can be measured to 1% by virtue of this effect, while in a steel which has been overloaded this effect may be used to reveal changes in the state of internal stress. Magnetic measurements show, for example, that a steel sample overstrained in tension is incapable of elastically resisting very small loads in compression (stress-strain curves show this same thing in the so-called Bauschinger effect). The change in magnetic properties caused by stress and the relation of these properties to fatigue have been extensively studied[23], and the knowledge gained has been successfully applied to commercial problems. But because of the complex nature of the magnetic properties and the extreme sensitivity of these properties to many influences, some of which have little effect on mechanical properties, it will be some time before magnetic analysis methods for non-destructive testing become fully developed.[24] At

**Radial stresses are not discussed in this paper. The principal assumptions made by Dawidenkow in his derivations are that the tube has a uniform wall thickness, that the stresses are distributed with rotational symmetry about the tube axis and remain constant along the axis, that each layer removed is very thin, and that the longitudinal strips are cut so narrow that a rectangular cross section can be assumed for them.

***See P. Goerens & R. Mailänder. Handbuch der Experimentalphysik, Vol. 5, pages 483-484, Akademische Verlagsgesellschaft. M. B. H., Leipzig, 1930, and bibliography there given, also papers on season cracking referred to in this review.

present magnetic analysis is incapable of quantitatively measuring a three-dimensional distribution of internal stresses in an object.

Summary

We have seen, then, that a number of mechanical methods of determining the intensity and distribution of internal stresses in metals have been proposed, but that each of them is applicable only in special and simple cases. The accuracy of many of the methods is seriously lowered by invalid assumptions as to the nature of the stress distribution. Sachs' boring-out method for rods and tubes and Dawidenkow's split tongue and ring method for tubes are, however, not dependent on unlikely assumptions and are superseding earlier approximate methods. Mather's non-destructive method, involving strain-gage measurements around a drilled hole, determines the internal stresses in more complicated shapes of specimens but is limited to cases of plane stress distribution. None of the mechanical methods reveals stresses balanced against each other in regions of microscopic size. Simple tests such as hardness, the bend test, the springing-out from a mandrel, and the time required for cracks to develop during immersion in a corrosive liquid, all give very indirect information on internal stresses and are not suitable as tools for most research projects, although frequently of value in practical problems. Other indirect methods are magnetic analysis, the reflection of polarized light, and internal friction.

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American Iron and Steel Institute Increases Directorate

The board of directors of the American Iron and Steel Institute will be increased from 30 to 32 members, it was decided at the annual meeting of members of the Institute held at its offices in New York today. The two new directors will be elected later. The ten directors whose terms expire in 1934 were all re-elected for three years. They are E. R. Crawford, President, McKeesport Tin Plate Company; George G. Crawford, President, Jones & Laughlin Steel Corporation; Harry G. Dalton, Chairman, Youngstown Sheet and Tube Company; W. J. Filbert, Vice Chairman, United States Steel Corporation; L. E. Geohegan, Vice President and General Manager, Gulf States Steel Company; W. W. Holloway, President, Wheeling Steel Corporation; Frank Purnell, President, Youngstown Sheet and Tube Company; W. F. Detwiler, Vice President, Allegheny Steel Company; George M. Verity, Chairman, American Rolling Mill Company; Homer D. Williams, President, Pittsburgh Steel Company.

New Officers of Electrochemical Society

At the recent Annual Meeting of the Electrochemical Society held at Asheville, N. C., the following new officers of the Electrochemical Society were elected: President, Dr. Hiram S. Lukens, University of Pennsylvania, Philadelphia, Pa.; Vice-Presidents, R. L. Baldwin, Niagara Falls, N. Y.; Alexander Lowy, Pittsburgh, Pa.; G. W. Heise, Cleveland, Ohio; James H. Critchett, New York City; Managers, L. R. Westbrook, Cleveland, Ohio; Shelock Swann, Jr., Urbana, Illinois; J. J. Mulligan, East Chicago, Indiana; Treasurer, Robert M. Burns, 463 West Street, New York City; Secretary, Colin G. Fink, Columbia University, New York City.

New Aluminum Bronze Powder Plant

Reynolds Metals Company has erected a new plant in Louisville, Ky., designed solely for the production of aluminum bronze powder for the paint industry.

Climax Molybdenum Advertisements Awarded Honors

Two advertisements of a series run in this publication were recently awarded honors at the thirteenth annual exhibition of the Art Directors' Club which was held at the RCA Building, New York City. The advertisements were for the Climax Molybdenum Company and won awards for art work and for layout of a complete advertisement. In preparing the advertisements a new type of art work known as "air brush art," was employed. The artist who prepared the ads was Alexey Brodovitch, and the art director Nelson Gruppo.

Impact Testing of Cast Iron

This extensive report on the usefulness of the several forms of impact test as applied to cast iron contains one of the most comprehensive series of data ever assembled on the physical properties of this material. The research work, extending over a period of three years, and the correlation of data was handled by Subcommittee XV on Impact Testing, of A.S.T.M. Committee A-3 on Cast Iron. This group enlisted the cooperation of other prominent workers in the field of cast iron. Some 500 test bars were specially cast, machined and tested by the several methods investigated, on the various types of machines commercially in use. Extensive tables give the results of the transverse, tension, fatigue, compression and shear tests which were made and by the use of charts and illustrations, these data are condensed in convenient form. Notched and unnotched Charpy and Izod tests were run, as well as repeated blow and drop tests. The conclusions of the committee in charge and the inclusion in the report of discussers' comments enhances the value of the publication. A chapter on the microstructure of irons in the impact investigation is included. Copies of the report, aggregating 51 pages, in heavy paper cover, can be obtained at 50 cents each from the American Society for Testing Materials, 260 South Broad Street, Philadelphia, Pa.

The Effect of Stress *on the* Transformation Temperature of Iron

by J. L. Holmquist*

When a specimen of iron, or other metal, is acted upon by a tensile force, the effect is to lengthen the specimen in the direction of the applied force, and to diminish its dimensions in the cross-section perpendicular to the direction of the force. This action is illustrated by Figs. 1 and 2, the dimensional changes being purposely exaggerated.

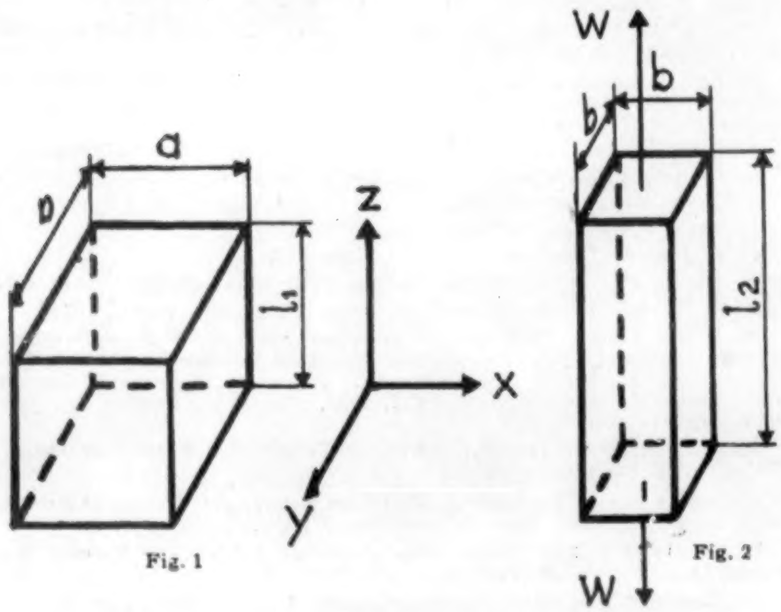

Fig. 1

Fig. 2

Figs. 1 and 2. Dimensional Changes due to Tension Stress.

It is known that the dimensional changes occur in such a manner that the volume of the stressed specimen is greater than that of the same specimen unstressed, i.e.:

$$a^2l_1 < b^2l_2$$

For the general case of a 3 dimensional stress distribution, it can be shown that the increase in volume, θ, per unit original volume is given by:

$$\theta = \frac{(\sigma_x+\sigma_y+\sigma_z)\,(1-2\mu)}{E} \qquad \text{(I)}$$

where σ_x, σ_y, and σ_z are the principal stresses, μ is Poisson's ratio, and E is Young's Modulus. If the specimen is loaded in pure tension, $\sigma_x = \sigma_y = 0$, and the increase in volume, or elastic dilation, θ, is given by,

$$\theta = \frac{(1-2\mu)}{E}\sigma_z \qquad \text{(II)}$$

When iron undergoes the $\alpha \rightarrow \gamma$ transformation, it is accompanied by a decrease in volume. If the specimen is maintained in a state of stress, and hence elastically dilated, the effect of the stress, by Le Chatelier's law, would be to raise the transformation temperature. The volume change, or elastic dilation, due to the applied stress, for thermodynamical purposes may be considered to be equivalent to the same volume change resulting from a suitable decrease in an initial external pressure applied to the specimen.

To obtain some idea of the magnitude of the increment in the transformation temperature due to an applied stress, the principles of elasticity, and thermodynamics can be combined to give a useful relation.

The effect of pressure on a system in equilibrium is given by the well known equation of Clapeyron:

$$\frac{dP}{dT} = \frac{\Delta H}{T\Delta V}; \text{ or, } \frac{dT}{dP} = \frac{T\Delta V}{\Delta H} \qquad \text{(III)}$$

where ΔV is the volume change accompanying the phase change, and ΔH is the change in heat content of the system.

The tensile stress applied to the specimen can be converted into an equivalent pressure producing the same volume change, by combining the relations defining the elastic dilation, and the compressibility. For the former, we have from equation (II):

$$\frac{d\theta}{d\sigma_z} = \frac{(1-2\mu)}{E} \qquad \text{(IV)}$$

and for the latter:

$$\frac{\theta}{V_0} = kP, \text{ and hence } \frac{d\theta}{dP} = kV_0$$

or for unit volume:

$$\frac{d\theta}{dP} = k \qquad \text{(V)}$$

where k is the coefficient of compressibility.

Combining (IV) and (V):

$$\frac{d\theta}{d\sigma_z} \cdot \frac{dP}{d\theta} = \frac{(1-2\mu)}{E} \cdot \frac{1}{k}$$

or:

$$\frac{dP}{d\sigma_z} = \frac{(1-2\mu)}{kE}$$

But $k = \frac{3(1-2\mu)}{E}$

$$\text{Hence } \frac{dP}{d\sigma_z} = \frac{(1-2\mu)}{\frac{3(1-2\mu)}{E} \cdot E} = \frac{1}{3} \qquad \text{(VI)}$$

Combining (III) and (VI)

$$\frac{dT}{dP} \cdot \frac{dP}{d\sigma_z} = \frac{1}{3}\,\frac{T\Delta V}{\Delta H}$$

or:

$$\frac{dT}{d\sigma_z} = \frac{T\Delta V}{3\Delta H} \qquad \text{(VII)}$$

Equation (VII) gives the effect of a one-dimensional stress distribution on the transformation temperature. The change in transformation temperature due to the application of a certain stress, σ_z, is obtained by integration of equation (VII). The exact integration (VII) would require that ΔV be known as a function of σ_z. ΔV depends on σ_z since α and γ iron have different compressibilities. If ΔV_0 is the volume change in the unstressed condition, and $\theta\alpha$ and $\theta\gamma$ are the elastic dilations of α and γ iron respectively, then the volume change, ΔV, resulting from the transformation occurring while subject to a state of stress σ_z, is given by:

$$\Delta V = \Delta V_0 + (\theta\gamma - \theta\alpha) \qquad \text{(VIII)}$$

$\theta\alpha$ and $\theta\gamma$ are both small as compared to ΔV_0, and their difference is much smaller. ΔV can therefore be considered as constant in equation (VII) without introducing substantial error.

On integration, equation (VII) therefore becomes:

$$\Delta T = \frac{T\Delta V}{3\Delta H}\sigma_z \qquad \text{(IX)}$$

In pure iron the $\alpha \rightarrow \gamma$ transformation occurs at about 900° C. or about 1180° K. The change in heat content, ΔH, is given by Austin[1] as $\Delta H_{906} = 218$ calories/gram atom, or about 30.4 calories/cc. of iron. Dilatometric observations indicate that $\Delta V = 0.75\%$ to 0.80% in nearly pure iron. If σ_z is taken as 5000 lbs./in.², we have on converting to consistent units:

$$\Delta V = 0.008 \text{ cc.}$$

$$\Delta H = 30.4 \text{ cal./cc.} = 12.7 \times 10^8 \text{ ergs/cc.}$$

$$\sigma_z = 5000 \text{ lbs./in.}^2 = 3.45 \times 10^8 \text{ dynes/cm.}^2$$

$$\therefore \Delta T = \frac{1180 \times 0.008 \times 3.45 \times 10^8}{3 \times 12.7 \times 10^8} = 0.86° \text{ C.}$$

The effect of any realizable simple stress on the transformation temperature is obviously quite small.

Sauerwald[2] and Sperling have investigated experimentally the effect of deformation on the transformation temperature of a pearlitic steel. In their experiments, heating and cooling curves were obtained on specimens sufficiently stressed in tension to produce plastic deformation during transformation.

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Their results were as follows:

Ac_1 : Lowered about 7° C. Ar_1 : Raised at most 1° C.
Ac_3 : Lowered about 4° C. Ar_3 : Raised about 4° C.

When austenite transforms, carbon is precipitated from solid solution as iron carbide. Since the density of iron carbide is less than that of α iron, the volume change accompanying the reaction: Austenite $\rightarrow \alpha$ iron + carbide, is less than that accompanying the transformation $\gamma \rightarrow \alpha$. The volume change decreases as carbon increases. The effect of stress on the transformation temperature should, therefore, be less in iron-carbon alloys than in pure iron.

The experimental conditions of Sauerwald and Sperling's work are not identical with those assumed in the foregoing theoretical treatment. The state of stress in the necked down section of the test specimen, and around the hole in which the thermocouple was inserted, is not simple tension. The applied stress is not stated, but was limited by the ultimate tensile strength of the material at elevated temperature, and probably did not exceed the 5000 lbs./in.^{2} employed in the previous calculation. Considering that the reported deviations in transformation temperature due to deformation (i.e. stress) are of the order of magnitude of the probable experimental error in determining the transformation temperature, the agreement between theory and experiment is satisfactory.

Thus far, only the effect of a homogeneous one-dimensional state of stress has been considered. As mentioned in the foregoing instance, the effect of a tension stress of this character is to raise the transformation temperature. The effect of other states of stress may be predicated with the assistance of equation (I). In equation (I) the principal stresses σ_x, σ_y, and σ_z are taken positive for tension and negative for compression. It is to be observed that when the sum $(\sigma_x + \sigma_y + \sigma_z)$ is negative, the elastic dilation is negative, and hence by Le Chatelier's law, the effect of the state of stress is to lower the transformation temperature. Further, if the sum $(\sigma_x + \sigma_y + \sigma_z)$ is zero, or of small magnitude, the effect of the stress on the transformation temperature is negligible, even though the individual stress components of the stress system are of considerable magnitude. The effect of stress on the transformation temperature may be positive, negative, or zero, depending on the particular stress system involved.

The most severe states of transient stress are doubtlessly incurred during the quenching operation. In the interior of quenched bodies, three-dimensional compressive stress systems occur, and as previously mentioned, the effect of such a stress system is to lower the transformation temperature. Given the state of stress, the temperature at which transformation would occur under equilibrium conditions can be calculated by means of the Clapeyron equation. Equilibrium conditions do not obtain during the quenching operation, the transformation temperature being greatly affected by the cooling velocity. The application of the Clapeyron equation under such conditions would not, therefore, give any information as to the temperature at which transformation would actually occur. It can only be noted in a qualitative manner, that the effect of compressive stress systems in lowering the transformation temperature would be to compensate to some extent for the slower cooling rates in the interior, and thus assist in deep hardening. Bain[3], however, has recently discussed some factors which exercise a more profound influence in this respect.

Since the thermal expansivity of γ iron is greater than that of α iron, the volume change accompanying the reaction $\gamma \rightarrow \alpha$ is greater the lower the temperature at which it occurs. This point is illustrated by the diagrammatic dilatometer curve shown in Fig. 3. The volume change is proportional to the linear length change, ΔL, occurring during transformation.

The effect of stress on the transformation temperature is, therefore, greater in those alloys which transform at lower temperature. Manganese and nickel are alloying elements, effective in lowering the true transformation temperature, and it would appear reasonable to attribute greater importance to the role of internal stress in promoting deep hardening properties to the alloys containing nickel or manganese. If a state of stress should be established in which $\sigma_x = \sigma_y = \sigma_z = -50{,}000$ lbs./in.^{2} (34.5×10^8 dynes/cm.^{2}), the lowering of the transformation temperature would be:

$$\Delta T = \frac{-1180 \times 0.008 \times 34.5 \times 10^8}{12.7 \times 10^8} = -26° \text{ C.}$$

To be effective, the state of stress must, of course, be established before transformation occurs. With this point in view, the above hypothetical example can, no doubt, be regarded as an extreme case. It would appear safe, therefore, to conclude that the role of stress in transformation phenomena is always very minor as compared to rate of change of temperature.

In the cooling of a heated body, the more rapid rate of cooling of the exterior leads, as has been noted, to the generation of compressive stresses in the interior. Similarly, in the heating of a body, the more rapid increase in the temperature of the exterior leads to the generation of tensile stresses in the interior. On heating, therefore, the effect of the stresses produced in the interior would be to raise the transformation temperature, while on cooling the effect would be to lower the transformation temperature. This circumstance naturally suggests internal stress as the cause of the hysteresis between critical points on heating and cooling. Since the agreement is qualitatively correct, the point must be decided on a quantitative basis. To estimate the transformation temperature elevation and depression due to internal stress, we have available the equations given by Scott[4] for the stresses in cylinders subject to temperature change.

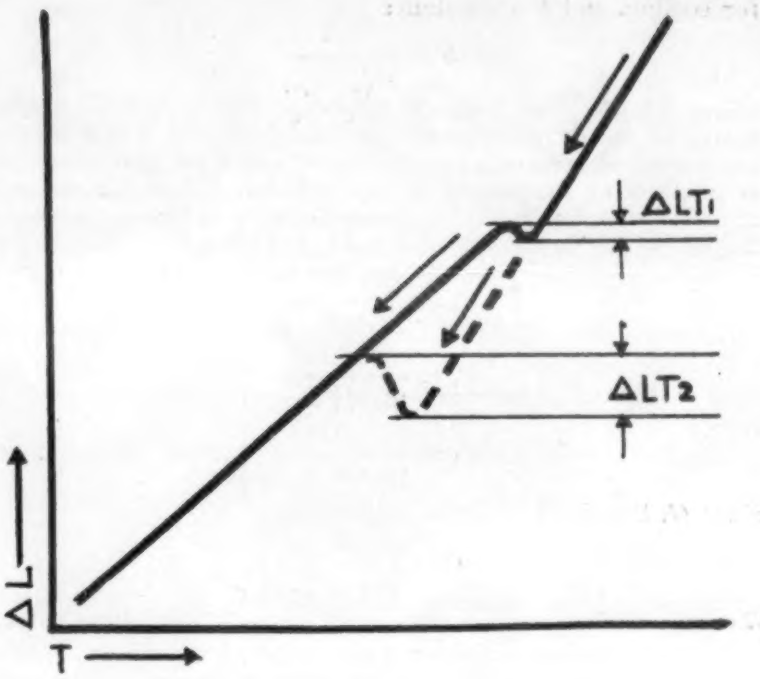

Fig. 3. Diagrammatic Dilatometer Curve.

These equations are:

$$F_a = \frac{kpc^2}{16} \cdot 2 \left[1 - \frac{2r^2}{c^2}\right]$$

$$F_r = \frac{kpc^2}{16} \cdot \left[1 - \frac{r^2}{c^2}\right]$$

$$F_t = \frac{kpc^2}{16} \left[1 - \frac{3r^2}{c^2}\right]$$

and the stress system they represent is shown in Fig. 4. Here r is the distance from the centre, c the radius, p the rate of temperature change taken positive for heating and negative

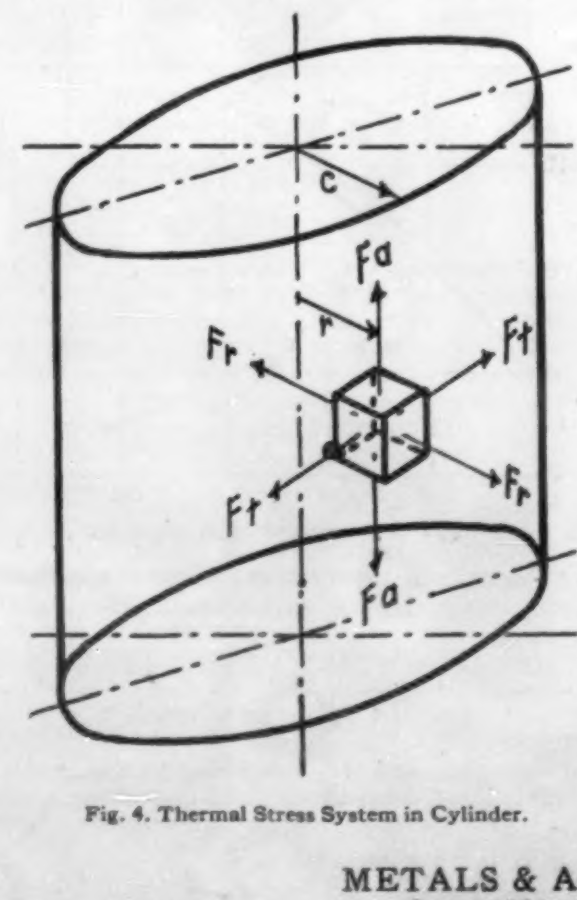

Fig. 4. Thermal Stress System in Cylinder.

for cooling, and k a constant:

$$k=\frac{\alpha E}{a^2(1-\mu)}$$

where α is the coefficient of expansion, E the modulus of elasticity, a^2 the diffusivity, and μ Poisson's ratio. These stresses are principal stresses, and the equations show that their sum is greatest at the centre of the cylinder. If we assume $p = \pm 6°$ C. per minute (0.1° C./second) and $c = 1$ cm., we have at the centre of the cylinder:

$$\left.\begin{aligned} F_a &= \frac{\pm 0.2\alpha E}{16a^2(1-\mu)} \\ F_r &= \frac{\pm 0.1\alpha E}{16a^2(1-\mu)} \\ F_t &= \frac{\pm 0.1\alpha E}{16a^2(1-\mu)} \end{aligned}\right\} \qquad \text{(X)}$$

Since G, the shear modulus is given by:

$$G=\frac{E}{2(1+\mu)} \qquad \text{(XI)}$$

We may eliminate μ from the equations (X) and thus obtain:

$$\left.\begin{aligned} F_a &= \frac{\pm 0.2\alpha}{16a^2}\,\frac{E}{2-\dfrac{E}{2G}} \\ F_r &= \frac{\pm 0.1\alpha}{16a^2}\,\frac{E}{2-\dfrac{E}{2G}} \\ F_t &= \frac{\pm 0.1\alpha}{16a^2}\,\frac{E}{2-\dfrac{E}{2G}} \end{aligned}\right\} \qquad \text{(XII)}$$

To evaluate these expressions, we have $\alpha = 0.000015$ per °C., and Scott[4] gives $a^2 = 0.05$ to 0.10 in cgs units. We will use the lower value. To evaluate E and G at 900° C., Fig. 5 is reproduced from Nadai's "Plasticity."[5] From Fig. 5, E is approximately 19×10^5, and G is 7.6×10^5 kg./cm.^{2} at 900° C. Substituting in (XII), we obtain:

$$F_a=\frac{\pm 0.2\times 0.000015}{16\times 0.05}\cdot\left\{\frac{19\times 10^5}{2-\dfrac{19}{2\times 7.6}}\right\}=\left\{\begin{array}{l}5.7 \text{ kg./cm.}^2\\ 5.6\times 10^6 \text{ dynes/cm.}^2\end{array}\right.$$

$$F_r=F_t=\pm\frac{F_a}{2}=\pm 2.85 \text{ kg./cm.}^2=2.8\times 10^6 \text{ deg./cm.}^2$$

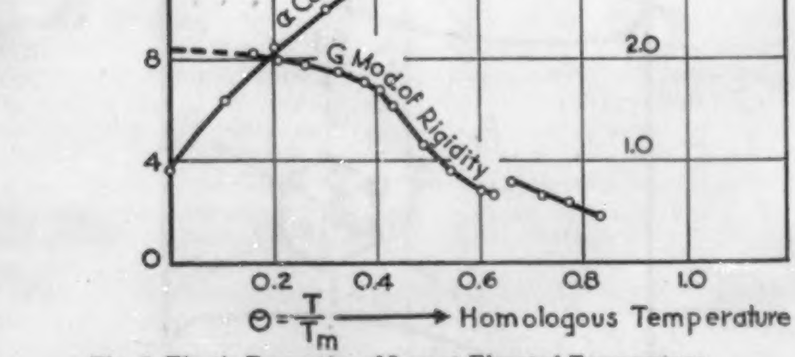

Fig. 5. Elastic Properties of Iron at Elevated Temperature.

The change in transformation temperature produced by these stresses would be:

$$\Delta T=\pm\frac{1180\times 0.008\times(5.6\times 10^6+2.8\times 10^6+2.8\times 10^6)}{3\times 12.7\times 10^8}$$

$$=\pm 0.028° \text{ C.}$$

The gap between Ac_3 and Ar_3 according to this result would be 0.056° C. This is, of course, much less than actually observed even with heating and cooling rates slower than 6° C./minute. It is to be concluded, therefore, that the gap between the critical points on heating and cooling cannot be ascribed to internal stress.

ACKNOWLEDGMENTS:

This analysis was made pursuant to a suggestion by Mr. G. M. Eaton, Director of Research, Spang, Chalfant & Co. Thanks are due Professor H. Seltz, Carnegie Institute of Technology, for criticism of a portion of the manuscript, and to Dr. M. Gensamer of the Metals Research Laboratory, Carnegie Institute of Technology, for data on the volume change occurring in the transformation of nearly pure iron.

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New Standard Samples

The National Bureau of Standards, Washington, D. C., has added standard samples of nickel molybdenum steel (S.A.E. 4615) and portland cement to its list of standard samples. The steel has the following composition: Carbon 0.203, Manganese .661, Phosphorus .023, Sulphur .020, Silicon .290, Copper .122, Nickel 1.75, Chromium .275, Molybdenum .214, Vanadium .004. This standard is No. 111 in the series and costs $2.50 per 150 grams. The cement, No. 114, is primarily for use in turbidimetric measurements of the surface area of cement. It has a surface area of 1900 sq.cm. per gram, and leaves 12.3% of residue on a No. 325 sieve when tested by the wet method. This standard costs $1.00 per sample of 35 grams. Samples must be paid for in advance with order. The former practice of sending samples C.O.D. has been discontinued.

New Two-Reel Film on Oxy-Acetylene Process

"The Prosperity Process," a new two- reel motion picture, has just been produced by the International Acetylene Association, 30 East 42nd Street, New York, N. Y. This picture shows the application of the oxy-acetylene process of welding and cutting metals to a wide range of industrial problems in the repair, reclamation and production of metal parts. The picture is suitable for technical society meetings, engineering colleges, technical, high and trade schools, student sections of the engineering societies, superintendents meetings, safety meetings, foremens club meetings, and other similar gatherings. It is a two-reel subject, requiring approximately 25 minutes for showing. The film is available in 16 mm. size, which can be shown on standard portable 16 mm. motion picture projectors. Arrangements to borrow this film can be made through the office of the Secretary of the Association. Organizations desiring the use of this picture should specify the date most convenient for its showing, together with an alternate date.

Glencoy Specialties Co. to Represent Ironton Fire Brick Co.

The Glencoy Specialties Co. of Zanesville, Ohio has been appointed special representative of The Ironton Fire Brick Co. of Ironton, Ohio, to cover the territory of Eastern Ohio, Western Pennsylvania and part of West Virginia.

L. A. Shea, who has been identified with the Main Office in charge of the Electrical Department of Hevi Duty Electric Company, Milwaukee, Wisconsin, has been appointed District Representative for the State of Ohio, with offices at 5005 Euclid Avenue, Cleveland, Ohio. He will have charge of the Company's service and sales agency on Electric Heat Treating Furnaces.

The Metallographic Determination of the Size Distribution of Temper Carbon Nodules

by H. A. Schwartz*

Many investigators,[1,2,3,4] have recognized the relation between the number of centers of crystallization and the rate of formation of the crystalline phase. This leads to the need of solving the mathematical problem of arriving at the number of nodules (say of graphite in malleable iron) from observations on a plane surface.

In a desire to develop a simple relationship between nodules per unit area and per unit volume many have fallen into error. If the simplifying assumption is made that all nodules are cut through their centers or not at all, then considering the nodules as uniformly distributed at the centers (or corners) of a series of cubes with one face parallel to the metallographic plane passing through one layer of nodules, then if n be the number of nodules per unit area and N the number per unit volume, $\frac{1}{n}$ is the area per nodule and $\sqrt{\frac{1}{n}}$ is the mean length of the cube edge hence $(\frac{1}{n})^{3/2}$ is the volume per nodule and $N = (\frac{1}{n})^{-3/2} = n^{3/2}$. The assumption may be justifiable if the diameter of the nodules is very small compared with their mean distances but is never rigorously correct and is very seriously incorrect for fairly large nodules. The size of the nodules cannot be omitted from any satisfactory treatment of the subject.

If it be assumed that all the nodules are of the same radius, r, then the nodules intersected by a given plane (that under examination) are all those having centers within a distance, r, from this plane in either direction. The number counted per unit area, n, is then the number whose centers lie in a volume of 2r thickness and the number of nodules per unit volume is $N = \frac{n}{2r}$. One may obtain the value of r by determining by measurement the largest diameter of nodule encountered for it is likely that, if many nodules are observed a few at least will be found cut near enough to the center to give an intersection equal within the experimental error to an equatorial section. Whether the basic assumption is or is not warranted is a matter of experimental fact. In an investigation of nodule growth it is not an admissible postulate for such problems have as part of their object the experimental verification of the size distribution.

Erich Scheil[4] has offered a solution of the problem involving the possibility of variation in size of nodules. The following is not a literal translation of Scheil's article but represents an expansion of his brief treatment of the subject which will, it is hoped, help the English reading student to a clearer understanding of the subject.

Consider that the size of spheres present does not vary continuously but that only spheres of given sizes exist, for example, those having radii of r, 0.9 r, 0.8 r . . . 0.2 r and 0.1 r. Calling these radii r_1, r_2, etc., let n_1, n_2, n_3 . . . n_{10} be the number of intercepts, observed per unit area of the metallographic plane, whose radii lie between r_1 and r_2, r_2 and r_3 . . . r_9 and r_{10} and under r_{10}. Call N_1, N_2 . . . N_{10} the number of spheres per unit volume having radii r_1, r_2 . . . r_{10}, respectively.

Now it is obvious that all the intercepts having radii over r_2 (= .9 r_1) are due to spheres of radius r_1. It can be shown that the chance that a plane intersecting a sphere at random will pass at such a distance from the center as to produce a circular intercept whose radius is over 0.9 that of the parent sphere, is .436 $(= \sqrt{1 - [0.9]^2})$, therefore, the total number of spheres of radius r_1 intercepted by the plane of observation is $\frac{1}{.436} n_1$. Since this plane intercepts all spheres whose centers lie within r_1 either way, $\frac{n_1}{.436}$ is the number of such spheres whose centers lie within r_1 of the plane of observation and since $N = \frac{n}{2r}$, $N_1 = \frac{n_1}{.436 \times 2r_1} = \frac{n_1}{.872\, r_1}$. The intercepts of radii lying between r_2 and r_3 are in part due to spheres of radius r_1 and the remainder to spheres of radius r_2.

Likewise the probability that a sphere intersected by a plane will yield an intercept whose radius falls between 0.8 and 0.9 the radius of the sphere is .164 $(= \sqrt{1 - [0.8]^2} - \sqrt{1 - [0.9]^2})$. Hence the number of intercepts of radius between r_2 and r_3 resulting from spheres of radius r_1 is $\frac{.164}{.436} n_1$, and the number of intercepts of this range of radii (per unit area) due to spheres of radius r_2 is $n_2 - \frac{.164}{.436} n_1$. This number of intercepts arises from those spheres of radius r_2 so intersected as to give circular intercepts of radii exceeding $\frac{8}{9}$ r_2, i.e., from .458 $(= \sqrt{.9^2 - .8^2}/.9)$ times the number of spheres of radius r_2 intercepted by the plane. All spheres of radius r_2 intercepted by the plane have their centers within that distance thereof. Hence, as before,

$$N_2 = (n_2 - \frac{.164}{.436} n_1) \div (2\, r_2 \times .458) = \frac{n_2}{.916\, r_2} - \frac{.164\, n_1}{.916 \times .436\, r_2}$$

It is obviously possible to extend this method, step by step, until all the intercepts are exhausted. Also we may substitute for r_2, r_3, etc., the values 0.9 r_1, 0.8 r_1, etc. The results can be expressed in such a form as $N_1\, r_1 = 1.146\, n_1$ (since $N_1 = \frac{n_1}{.436 \times 2\, r_1}$).

We thus express N_1, N_2 . . . as fractions whose numerators involve n_1, n_2 . . . and whose denominator is $2\, r_1$ the diameter of the largest intercept. These numerators represent the number of nodules to be found in a slab of unit area and thickness $2\, r_1$ extending equally (r_1) in each direction from the metallographic plane. The coefficients of the various values of n in the numerators of the fractions whose denominator is $2\, r_1$, and which express the values of N_1, N_2 . . . are tabulated below.

To determine the number of spheres of given radius to be found in unit volume of the material one adds the products of the observed values of n_1, n_2 . . . and the coefficients listed in the line corresponding to the proper size and divides the result by $2\, r_1$.

Thus, if one desires N_4 he evaluates

$$\frac{2.79\, n_4 - 1.02\, n_3 - .32\, n_2 - .16\, n_1}{2\, r_1}$$

by setting for n_1, n_2, n_3 and n_4 the values obtained by counting and for $2\, r_1$ the observed diameter of the largest spheres. Algebraically N_1, N_2, etc., may thus be regarded as coefficients of $2\, r_1$ in an equation whose right half is the sum of the products of n_1, n_2 . . . by the coefficients set opposite to the selected N in the table.

Table 1

Coefficient of $2\, r_1$	Coefficient of n_1	n_2	n_3	n_4	n_5	n_6	n_7	n_8	n_9	n_{10}
N_1	+2.29									
N_2	—.91	+2.43								
N_3	—.31	—.96	+2.58							
N_4	—.16	—.32	—1.02	+2.79						
N_5	—.08	—.17	—.34	—1.11	+3.02					
N_6	—.05	—.09	—.18	—.37	—1.17	+3.33				
N_7	—.04	—.06	—.09	—.17	—.40	—1.21	+3.78			
N_8	—.04	—.03	—.05	—.09	—.15	—.47	—1.39	+4.47		
N_9	—.01	—.01	—.03	—.05	—.08	—.17	—.41	—1.58	+5.77	
N_{10}	±.00	+.01	—.01	—.02	—.05	—.05	—.13	—.35	—1.54	+10.0
ΣN	+.69	+.80	+.86	+.98	+1.17	+1.43	+1.85	+2.59	+4.23	+10.0

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Table 1, of course, represents equations of the following form:

$$2\,r_1\,N_1 = 2.29\,n_1 \text{ or } N_1 = 2.29\frac{n_1}{2\,r_1};\; N_2 = -.91\frac{n_1}{2\,r_1} + 243\frac{n_2}{2\,r_1};$$

$$N_3 = -.31\frac{n_1}{2\,r_1} - .96\frac{n_2}{2\,r_1} + 2.58\frac{n_3}{2\,r_1};\text{ etc.}$$

where N_1 = the number of spheres per unit volume of radius r_1

N_2 = the number of spheres per unit volume of radius $r_2 = .9\,r_1$

N_3 = the number of spheres per unit volume of radius $r_3 = .8\,r_1$

and n_1, n_2 and n_3 = the number of circles counted per unit area of the observed section of radii r_1, r_2 and r_3 respectively.

The coefficients are given to the second decimal only and it is thought that the uncertainties of metallographic observation scarcely warrant anything more or a subdivision into over 10 sizes. A similar table could readily be computed of greater precision in both respects if desired.

Attention is invited to certain apparent small discrepancies, most notably the coefficient of n_2 in the expression for N_{10}. The table gives this as positive though in principle it must be negative. Such variations are the results of taking the nearest figure in the last decimal place, the error being multiplied in passing from a layer $2\,r_{10}$ thick to one $2\,r_1$ thick. It was thought better to warn the reader against confusion from such small matters than to attempt a smoothing out of the mechanically calculated series of numbers to conceal them.

Table 1 seems in more useful form for the intended purpose than do Scheil's methods of calculation. By the use of the table one may calculate the number of nodules of any or all sizes and the total number independently while Scheil's methods require the calculation to be made in sequence for each successive size.

It is also possible that the utilization of Table 1 will be more clearly understood in the light of the present developments than Scheil's method as described somewhat incompletely by himself. The writer is indebted to one of Scheil's pupils, Dr. Wolfram Ruff, for a verbal discussion of Scheil's viewpoint which proved both interesting and useful.

It can be shown that on subdividing the observed nodules or circles into only 5 instead of 10 sizes, which may be sufficient for some metallographic observations, only the right hand half of Table 1 need be used beginning with N_6 and n_6; the coefficients of $2\,r_1$, however, would have to be multiplied by the factor $\frac{10}{5}$. On subdividing into only 4 sizes the 4 right hand columns of Table 1 would be used and the coefficients of $2\,r_1$ multiplied by the factor $\frac{10}{4}$; etc. The following illustrates this and also gives a concrete example of the use of the table.

The graphite nodules on a micrograph at 100$\times$ of malleable iron were measured and counted.* The largest nodules at 100$\times$ were 5 mm. in diameter and the smallest were 1 mm. in diameter. The real area represented by the micrograph was 0.522 mm.[2] The count of these and the intermediate sized nodules was as follows:

	Diameters of Nodules				
	Between 4 and 5 mm.	Between 3 and 4 mm.	Between 2 and 3 mm.	Between 1 and 2 mm.	Between 0 and 1 mm.
Number of nodules of each diameter in the micrograph	11	17	12	24	24
Nodules per unit area	21	33	23	46	46
Designation of the number in Table 1	n_6	n_7	n_8	n_9	n_{10}

Now substituting in the equations represented by Table 1 and recalling that $2\,r_1$, the diameter of the largest nodule was 5 mm. at 100$\times$, or .05 mm., and multiplying the coefficients of $2\,r_1$ by the factor $\frac{10}{5}$, we get

$$2\,r_1 \times \frac{10}{5} \times N_6 = 3.33\,n_6 \text{ or}$$

$$N_6 = \frac{3.33}{2}\times\frac{21}{.05} \qquad = 701 \text{ per mm.}^3$$

$$N_7 = -\frac{1.21}{2}\times\frac{21}{.05} + \frac{3.78}{2}\times\frac{33}{.05} \qquad = 971 \text{ per mm.}^3$$

$$N_8 = -\frac{.47}{2}\times\frac{21}{.05} - \frac{1.39}{2}\times\frac{33}{.05} + \frac{4.47}{2}\times\frac{23}{.05} \qquad = 483 \text{ per mm.}^3$$

$$N_9 = -\frac{.17}{2}\times\frac{21}{.05} - \frac{.41}{2}\times\frac{33}{.05} - \frac{1.53}{2}\times\frac{23}{.05} + \frac{5.77}{2}\times\frac{46}{.05} \qquad = 2227 \text{ per mm.}^3$$

$$N_{10} = -\frac{.05}{2}\times\frac{21}{.05} - \frac{.13}{2}\times\frac{33}{.05} - \frac{.35}{2}\times\frac{23}{.05} - \frac{1.54}{2}\times\frac{46}{.05} + \frac{10}{2}\times\frac{46}{.05} \qquad = 3753 \text{ per mm.}^3$$

A tabulation of the coefficients for a distribution into 5 sizes is appended and may be found more convenient if slightly less accurate than the longer table.

Table 2

Coefficient of $2\,r_1$	Coefficient of n_1	n_2	n_3	n_4	n_5
N_1	1.666				
N_2	— .605	1.890			
N_3	— .235	— .695	+2.235		
N_4	— .085	— .205	— .765	+2.885	
N_5	— .025	— .065	— .175	— .770	+5.0
Σ N	0.716	0.925	1.295	2.115	5.0

It may be pointed out that in the usual determination of grain number per unit volume, or grain size, the average grain size is given, all of the grains being assumed to be of nearly the same size. While this is often true, it also frequently happens that the grains are far from being the same size. For studies of the phenomena of grain growth, grain growth inhibitors, germination, etc., it would be of interest to determine the size distribution of the grains as well as the average grain size. This can be done by the use of the method indicated in Table 1 provided the system corresponds to the postulated conditions of spherical masses of one phase growing in another. The probability conditions are not fulfilled when the spheres are distorted by contact with their neighbors in a multicrystalline mass.

[1]H. A. Schwartz. Graphitization at Constant Temperature. *Transactions American Society for Steel Treating,* Vol. 9, 1926, page 885.

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*By S. Epstein, Metallurgist, Battelle Memorial Institute.

Battelle Announcements

Chester R. Austin, who received his B.S. in 1928 and M.S. in 1929 in Ceramic Engineering at Ohio State University, has joined the technical staff of Battelle. From 1929-33 Austin was at the Roseville Experiment Station of Ohio State University. His work included a survey of Ohio shales and surface clays, developments in improvement in fuel practice for the ceramic industries, de-airing of clays, and testing of ceramic products, which makes him well qualified for the special refractory project to which he has been assigned at the Institute. Austin is a member of the American Ceramic Society and Sigma Xi. Before coming to Battelle, he was employed as compressor engineer by the Ohio Fuel Gas Company, Cambridge, Ohio.

A. C. Richardson, formerly with the Bureau of Mines at its Southern Experiment Station in Tuscaloosa, Alabama, where he was employed in coal cleaning and ore dressing investigations, has been appointed to the technical staff at Battelle where he will work under the direction of Byron M. Bird, chief concentration engineer.

Research looking toward improving the quality of copper alloys castings is being sponsored by the Falcon Bronze Company of Youngstown, Ohio.

This research project will be conducted at Battelle Memorial Institute, Columbus, Ohio, **C. H. Lorig** will be in charge of the project.

ORE CONCENTRATION (1)

JOHN ATTWOOD, SECTION EDITOR

Iron Ore for Centuries in Mesabi Range; Fair Tax Key to Development. E. W. DAVIS. *Steel,* Vol. 92, May 8, 1933, pages 13-14, 59-60. Summarizes study by the University of Minnesota Mines Experiment Station. There is an enormous deposit of low-grade ore on the Mesabi which can be concentrated into desirable high-grade products. With development of better mining and concentrating methods this ore can be utilized economically for generations. MS (1)

Crushing, Grinding & Plant Handling (1a)

Grinding Pans for Gold and Tin Ores. J. W. WARDELL. *Crushing & Grinding,* Vol. 2, May-June 1933, page 7. Descriptive. AHE (1a)

A Gearless Secondary Gyratory Crusher. *Edgar Allen News,* Vol. 12, Dec. 1933, pages 353-356; Feb. 1934, pages 388-389. A crusher for stone and ore which requires a not very heavy foundation and has no gears, pinions, pulleys or belts and therefore cheap maintenance, is described in detail. Ha (1a)

Liberation of Oölithic and Pea-like Iron Ores (Ueber die Aufschliessung von oolithischen und bohnerzartigen Eisenerzen) W. LUYKEN & L. KRAEBER. *Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung,* Düsseldorf, Vol. 15, No. 16, 1933, pages 197-203. The difficulties in preparing and dressing oölithic iron ores are discussed, they consist mostly in that the Fe-rich oölithes are crushed also when crushing the rocky mass which is not desirable. 3 different processes were tried of which crushing in mills with rubber-covered bars did not give satisfactory results while reducing to small pieces by dropping seems only a laboratory solution. Blasting offered the most promising results as the ore was neatly separated from the other mass. 7 references. Ha (1a)

Deformation of Solids. J. KOSTER. *Progress Reports—Metallurgical Division. I. Mineral Physics Studies. United States Bureau of Mines, Report of Investigations* 3223, Feb. 1934, pages 15-18. Results are presented of a mathematical investigation of the mechanism of deformation and fracture of solids, as bearing on energy requirements in crushing and grinding. AHE (1a)

Measurement of Crushing Resistance of Minerals by the Scleroscope. R. S. DEAN, JOHN GROSS & C. E. WOOD. *Progress Reports—Metallurgical Division. I. Mineral Physics Studies. United States Bureau of Mines Report of Investigations* 3223, Feb. 1934, pages 33-35. Energy absorbed (difference between height of drop and rebound in a scleroscope) was directly proportional to the weight of material crushed per unit of work. Effect of various variables on the results is discussed. AHE (1a)

Ball Milling. ALEXANDER M. GOW, M. GUGGENHEIM, A. B. CAMPBELL & WILL H. COGHILL. *American Institute Mining & Metallurgical Engineers, Technical Publication* No. 517, Feb. 1934, 52 pages. The fundamentals of ball milling are discussed and it is concluded that net power is the only reliable criterion of the process. A study of ball paths and trajectories does not lead to an explanation of power requirements and efficiency of the process. A series of laboratory experiments on grinding a hard mineral and a soft mineral is described. A correlation is made between laboratory and field tests. Method and formula are offered whereby the power required by a cylindrical mill of any size and operation under any conditions may be estimated. It is suggested that the present closed circuits be supplemented by classifiers and tables so as to avoid overgrinding and that rolls be used for preparation of the finer ball-mill feeds. More information is needed on the influence of the amount of ore in a mill. JLG (1a)

Progress in Explosive Shattering of Minerals. JOHN GROSS. *Progress Reports—Metallurgical Division. I. Mineral Physics Studies. United States Bureau of Mines Report of Investigations* 3223, Feb. 1934, pages 19-32. Increased pressures cause small increases in shattering. With increasing weight of charge, the shattering per g. of H_2O increases. Impact of particles against a solid barrier results in considerable shattering. Material from one explosion is nearly as susceptible to subsequent explosive shattering as the original. Less fines are made by the explosive shattering than by ordinary crushing. There is a differential shattering with many ores which concentrates the values more than mechanical crushing. A machine for explosion shattering is described. AHE (1a)

Magnetic Separation (1d)

Magnetic Separation of Minerals. R. S. DEAN, V. H. GOTTSCHALK & C. W. DAVIS. *Progress Reports—Metallurgical Division. I. Mineral Physics Studies. United States Bureau of Mines, Report of Investigations* 3223, Feb. 1934, pages 3-13. After magnetic properties are discussed in general, data are given on the D.C. susceptibility and A.C. activity before and after various kinds of heat treatment for many minerals. A separator is described briefly in which magnetized mineral particles on a tilted non-magnetic belt pass over an A.C. magnetic field. The slight repulsion of the particles having high coercive force overcomes the friction on the belt and the particles fall off. AHE (1d)

Amalgamation, Cyanidation & Leaching (1e)

Reduction Works Practice at Morro Velho, Brazil. JACK H. FRENCH & HAROLD JONES. *Bulletin Institution Mining & Metallurgy,* No. 339, Dec. 1932, 45 pages; No. 340, Jan. 1933, pages 1-15; No. 341, Feb. 1933, pages 45-48; No. 346, July 1933, pages 1-12. Present methods of cyaniding a complex quartz-carbonate-sulphide ore containing pyrrhotite are described in detail. Au content averages 12 dwt./long ton and contains 23% Ag. Generally it is associated with arsenopyrite and in contact with pyrrhotite. The ore is concentrated by tabling and then cyanided. Thick pulps are used, since pyrrhotite is such a strong cyanicide that the foul solutions can not be returned to the circuit. Best results are obtained with low alkalinity, approximately ½ lb./ton. Precipitation is by Zn. Details of these steps and of the refinery practice are given. AHE (1e)

Milling Methods and Costs at the Golden Cycle Mill, Colorado Springs, Colo. L. S. HARNER. *United States Bureau of Mines, Information Circular* No. 6739, July 1933, 18 pages. Sulphotelluride Au ores are treated by roasting and cyanidation. Complex sulphide ores are floated, and the concentrate roasted. Very careful attention to details of roasting is necessary. Complete removal of free Au particles of any appreciable size is essential. Consumption of chemicals, formation of $CaSO_4$ and other cementing compounds and amounts of deleterious sulphides produced vary with the types of ore and manner of roasting. Recovery of Au is decreased by accumulation of Zn salts in the cyanide solutions. Sufficient sulphides usually are present in the calcines to precipitate injurious soluble Zn, but when recovery decreases, addition of soluble sulphides in general is beneficial. Sand and slimes are difficult to wash. For 1929, heads assayed 0.502 oz./ton; recovery was 96.81% divided as follows: amalgamation 25.33, cyanidation before classification 55.10, cyanide sand leaching 10.70 and cyanide slime leaching 5.68%. Reagent consumption was cyanide 0.964 lb/ton of ore, hydrated lime 6.119 lbs., Zn-dust 0.269 lb., HCl 0.169 lb., and Pb acetate 0.037 lb. Total costs were $2.2139. AHE (1e)

Amalgamation Tests on a Sample of Gold Ore from the Beaufor Gold Mines, Ltd., Pascalis Township, Northern Quebec. J. S. GODARD. *Canada Department of Mines, Mines Branch, Report* No. 728, 1932, pages 87-93. A Au ore assaying 1.82 oz./ton was amalgamated to give 85% recovery. An additional 12-13% of Au may be recovered by cyanidation of tailing or flotation of tailing and cyanidation of concentrate. AHE (1e)

ORE REDUCTION (2)

A. H. EMERY, SECTION EDITOR

Non-Ferrous (2a)

On the Granulation of Blast Furnace Slags (Zur Granulierung der Hochofenschlacken) GUSTAV KROUPA. *Montanistische Rundschau,* Vol. 26, Feb. 16, 1934, pages 7-8. Discusses a new method for granulating blast furnace slag described in *Iron and Coal Trades Review.* The slag is treated in a rotary granulator, 10 ft. in diameter, equipped with beaters and 3 narrow pipes through which H_2O is introduced into the molten bath. It has a power requirement of 40-50 h.p., with a capacity of 20 tons of dry slag/hr. In an installation in the Ruhr district the granulated slag contained only 5% H_2O, compared with 30% in the old method, thus eliminating the drying of the granulated material and saving 30 tons of coal/1,000 tons of slag. Such material has better physical characteristics than slag granulated by pouring into a stream of cold H_2O. BHS (2a)

Boliden Mine (Boliden Gruvan) E. WESSLAU. *Tekniska Föreningens in Finland Förhandlingar,* Vol. 54, Feb. 1934, pages 29-52. The smelter and refinery at Rönnskär, Sweden, capacity 30,000 metric tons of ore/month, are described. Ore is roasted in 12 50-ton mechanical roasting furnaces and 1 50-ton rotary kiln. Calcine containing 8% S is smelted in 3 reverberatory furnaces to a matte assaying 17% Cu, 165 g./t. Au, and 500 g./t. Ag. Four Bessemer converters produce 98% Cu blister which is treated in a coal-dust-fired, tilting furnace and cast into 125-kg. anodes. The electrolytic refinery has 192 cells, 21 anodes/cell, current density 135 amp./m.^{2} and an annual capacity of 6,000 tons Cu. Anode slime is treated by oxidizing roast with soda, whereby the Se is converted into sodium selenite and selenate which are dissolved in water; the residue is leached with H_2SO_4 to dissolve Cu and most of the Ag. Ag is precipitated with Cu and cast into anodes which are electrolyzed in acid $AgNO_3$ solution. Residue from acid leach contains Au with some Ag and Pb. It is leached with NaOH and cast into anodes which are electrolyzed in $AuCl_3$ solution. As in smelter gases, about 50,000 tons annually, more than the total world consumption, is kept in a special storage. BHS (2a)

Judging Removal of Sulphur and Arsenic from Copper in the Reverberatory Furnace by the Laws of Physical Chemistry (Beurteilung der Entschwefelung und Entarsenung des Kupfers im Flammofen nach den Gesetzen der physikalischen Chemie) EM. LUBOJATZKY. *Metall und Erz,* Vol. 30, Aug. 1933, pages 311-313. The fact that the concentration of the sulphides and arsenides of Cu is inversely proportional to the square root of their vapor pressures can be used to calculate their quantities during smelting in the reverberatory furnace. The mass law of decomposition of sulphides and arsenides is used to deduce equations for calculating the removal of S and As according to furnace temperatures. CEM (2a)

Application of Waelz Process to Karabash (Russia) Copper-Zinc Ores and Mixed Concentrates. A. N. VOLSKY, R. A. AGRACHEVA & N. G. SEREBRENNIKOVA. *Tzvetnuie Metallui,* Mar. 1932, pages 322-346. The applicability of the Waelz process to the ores of Karabash district was investigated. The complex ores contain sphalerite, chalcopyrite, tennantite, pyrite, and other minerals, the average analysis being as follows: Cu 3-4%, Zn 3-7%, Pb 0.2-0.5%, As 0.2-0.9%, Fe 33-40%, Au 13-66 g./ton, Ag 1.2-1.9 g./ton, and S 43-46%. Because of the low Zn content of the ores the direct application of the Waelz process was not justified, and, therefore, the concentration of these ores was investigated with the aim of producing a Cu-Zn concentrate since selective flotation did not give satisfactory results. The average metal content of the concentrates was: Cu 12-15%, Zn 20-23%, Pb 0.7 to 2.5%, As 0.7-2.2%, Fe 20-30%, Au 66-110 g./ton, Ag 4 g./ton, and S 35-40%. The recovery in flotation was Cu and Zn 90-95%, Au and Ag 60-70%. Experiments showed that volatilization of Zn takes place on heating in a reducing atmosphere both when using roasted and unroasted concentrates. With un-roasted concentrates erosion of furnace walls was considerable, and Zn volatilization was not as good as with roasted ores. In the commercial application of the Waelz process the volatilization of not less than 95% of Zn is expected. The Zn oxide contains some Pb and As, although most of the As (85%) is volatilized in roasting. The furnace temperature need not be above 1100°. The residue obtained from treating roasted concentrates consists mainly of metallic Cu (16-20%), and Fe and its oxides, mainly magnetic (total Fe 37-44%). The Fe oxides can be reduced, and a product consisting almost entirely of Cu and Fe may be obtained. By remelting, this product can be separated into Cu, containing some Fe, and cupriferous Fe. The residue may also be treated together with Cu mattes in a converter, or can be smelted together with Cu concentrates. The coal consumption is about 40% of the weight of the roasted concentrate. BND (2a)

The Noranda Smelter. W. B. BOGGS & J. N. ANDERSON. *Transactions American Institute Mining & Metallurgical Engineers,* Vol. 106, 1933, pages 165-201. Describes Cu smelter, completed in 1927, containing 8 Wedge roasters and 2 reverberatory furnaces. A large quantity of low-grade matte is blown in 4 converters. The blister is fire refined and cast into anodes. Details of furnaces and auxiliary equipment are given. In 1930, 75,000,000 lb. of Cu were produced. See also *Metals & Alloys,* Vol. 1, Oct. 1930, page 790. JLG (2a)

A Brief Description of the Reduction Plant of the Chile Exploration Company at Chuquicamata, Chile, S. A. T. C. CAMPBELL. *Transactions American Institute Mining & Metallurgical Engineers,* Vol. 106, 1933, pages 559-608. Describes crushing, leaching, melting and refining of Chile Cu. JLG (2a)

History of Reverberatory Smelting in Montana, 1879 to 1933. FREDERICK LAIST. *Transactions American Institute Mining & Metallurgical Engineers,* Vol. 106, 1933, pages 23-87. Describes the various types of Cu-smelting furnaces used in Montana during the past 50 years with drawings and photographs. Smelting with natural gas is discussed. JLG (2a)

Recovery of Suspended Solids from Furnace Gases in Copper Smelters, with Special Reference to the Cottrell Process of Electrical Precipitation. HARRY V. WELCH. *Transactions American Institute Mining & Metallurgical Engineers,* Vol. 106, 1933, pages 296-323. Describes Cottrell process and installations at Cu plants. An appendix gives formulae for use in calculating dust separation. 43 references. JLG (2a)

Production of Arsenic Trioxide at Anaconda. LOUIS V. BENDER & HAROLD H. GOE. *Transactions American Institute Mining & Metallurgical Engineers,* Vol. 106, 1933, pages 324-328. Describes development of process and present practice of producing As_2O_3 as a byproduct of Cu smelting. JLG (2a)

Ammonia Leaching at Kennecott. E. J. DUGGAN. *Transactions American Institute Mining & Metallurgical Engineers,* Vol. 106, 1933, pages 547-558. Describes NH_3 leaching of Cu concentrates in Alaska. Gives production and cost data. JLG (2a)

The Inspiration Leaching Plant. HAROLD W. ALDRICH & WALTER G. SCOTT. *Transactions American Institute Mining & Metallurgical Engineers,* Vol. 106, 1933, pages 650-677. Describes plant of Consolidated Copper Co. JLG (2a)

Chemical and Physical Features of Copper Leaching. JOHN D. SULLIVAN. *Transactions American Institute Mining & Metallurgical Engineers,* Vol. 106, 1933, pages 515-546. The author's previously published work on the leaching of oxide-sulphide Cu ores is reviewed; some unpublished data are included. Most of the work has to do with the speed of solution under different conditions. 25 references. JLG (2a)

The Distribution of Porosity in Copper Ingots. N. P. ALLEN. *Metal Industry,* London, Vol. 42, Apr. 21, 1933, pages 417-420; Apr. 28, 1933, pages 443-446; *Engineering,* Vol. 135, Mar. 31, 1933, pages 362-363. See *Metals & Alloys,* Vol. 5, Jan. 1934, page MA 30. LFM+Ha (2a)

Repairing a Large Smelter Chimney Injured by Spalling. John E. Lanning. *Transactions American Institute Mining & Metallurgical Engineers,* Vol. 106, 1933, pages 282-295. A chimney 430 ft. high had spalled above the 115-ft. level. The outside was reinforced with a gunite layer 2½" thick. The inside was cleaned and lined with a layer of brick set in an acid-proof mortar. JLG (2a)

Separation of Lead and Zinc Electrothermally (Sur la separation du plomb d'avec le zinc par voie électrothermique) B. Bogitch. *L'Industrie Électrique,* Vol. 42, Feb. 10, 1933, page 67. See *Metals & Alloys,* Vol. 5, Jan. 1934, page MA 12. Ha (2a)

Balz Furnace and its Suitability for Roasting Ore for Zinc Electrolysis (Der Balzofen und seine Eignung zum Rösten von Erzen für die Zinkelektrolyse) Otto Kühle. *Metallwirtschaft,* Vol. 12, Nov. 24, 1933, pages 683-688. The construction and operation of the Balz furnace are described in detail. Its advantages over other types of furnaces for roasting Zn blende are (1) compact construction with low muffles, (2) the driving mechanism located on the outside removed from the heat and chemical attack, and (3) temperature regulation of the air used to burn the sulphides. Part of the air entering the furnace is cold to prevent fusing of the charge at the start of the roasting; preheated air is introduced near the end to obtain a completely roasted product. The operating costs are lower than for other types of furnaces. At 840°C., the ore is roasted in 8 hrs. to a sulphide S content of 0.4% or less and with the formation of very little ferrite and silicate compounds. Samples from 8 lots of Zn blende from various sources were roasted in a Balz furnace and leached in H_2SO_4 according to the Anaconda and Tainton processes. The Zn solubility was 92 to 99%, and 96 to 99%, respectively; the ferrous Fe averaged 0.05% and 0.16%. CEM (2a)

Modern Metallurgical Processes for Increasing the Purity of Aluminum, their Commercial Importance and Development (Die neuzeitlichen hüttenmännischen Verfahren zur Erhöhung des Reinheitsgrades von Aluminium, deren technische Bedeutung und Auswirkung) Hans Bohner. *Metall und Erz,* Vol. 30, Sept. 1933, pages 334-339. To obtain Al 99.6% pure, it is better to refine the Al_2O_3 and then electrolyze than to electrolyze crude Al_2O_3 and refine the metallic Al. (1) Alkali processes. In the Bayer process the bauxite is dried to 0.5-1% moisture, ground, and treated with NaOH solution forming $NaAlO_2$. The insoluble oxides of Fe, Si and Ti are filtered off. Incorrect NaOH concentration dissolves SiO_2. After filtering, the $Al_2O_3 : Na_2O$ ratio should be 1:5. Al_2O_3 thrown down by stirring the solution at 40°-60°C., is calcined. The NaOH can be reused. For the Löwig process, the bauxite must be finer but need not be as dry. It is mixed with Na_2CO_3 and sintered in long ovens at 950°-1150°C., forming $NaAlO_2$ and CO_2. The $NaAlO_2$ is dissolved in NaOH solution and CaO is added to precipitate SiO_2 and TiO_2, which are filtered off. After precipitating the bulk of the $Al(OH)_3$ and filtering off, CO_2 is passed through the solution to obtain the remaining $Al(OH)_3$. This is not as pure as the first. The Peniakoff process is similar to the Löwig process, but Na_2SO_4 and coke are used instead of Na_2CO_3. CO_2 is used to precipitate all of the Al. The ore used in the alkali processes should not contain more than 5% SiO_2. (2) Acid processes are not practical as it is impossible to obtain Al free from Fe. (3) Electrothermic processes. In the Hall process modified by Haglund, bauxite, coke, and pyrites are reduced to metallic Al in an electric furnace, part of the Al forming AlS. Fe containing Si, Ti and Al is obtained as byproduct. The Al produced is as pure as in the Bayer process and is cheaper. For the reduction process pure Al_2O_3 and cryolite are necessary. To obtain Al 99.9% pure and higher the Hoopes process is used. Increasing the purity of Al from 98.5% to 99.6% increases electrical conductivity, increases chemical corrosion resistance and alters physical properties of alloys made from it. 12 references. CEM (2a)

New Methods in the German Aluminum Industry (Ein neuer Weg für die deutsche Aluminiumindustrie) E. Reitler. *Technische Blätter der deutschen Bergwerkszeitung,* Vol. 23, Dec. 31, 1933, pages 729-731. Freitag. *Oberflächentechnik,* Vol. 11, Feb. 6, 1934, pages 27-28. Proposals for economically extracting Al from clay are discussed, including the Bucherer method of electrolysing Al from Al sulfides dissolved in a melt of NaCl and KCl and the similar method of the Aluminium Industrie Neuhausen, Switzerland. The Institute of Non-Ferrous Metallurgy and Electro-Metallurgy of the Technische Hochschule Aachen found that this Al sulfide is AlS and not Al_2S_3. Al contaminated with Fe and Si can be made easily from common clay. It gave AlS of 97.6% purity by treatment with FeS at 1200-1300°C. The decomposition voltage of a melt of 60% AlS and 40% NaCl at 650° was about 1 volt lower, electrode consumption was lower, current consumption was 25% lower, and the working voltage lower by about 20% than with Al_2O_3 electrolysis. Ha+GN (2a)

Manufacture of Magnesium (La fabrication du magnésium) A. Dumas. *Revue de Metallurgie,* Vol. 30, Dec. 1933, pages 511-519. Brief description of the processes used for preparation of anhydrous $MgCl_2$ and production of metallic Mg. JDG (2a)

Reduction of Beryllium Chloride with Metallic Aluminum (Zur Frage der Reduzierbarkeit von Berylliumchlorid mit metallischem Aluminium) Walter Kangro. *Metall und Erz,* Vol. 30, Oct. 1933, pages 389-390. Beryl can be treated at high temperature with Cl gas to form $BeCl_2$. It is proposed to heat $BeCl_2$ and Al together according to the reaction $3\ BeCl_2 + 2\ Al = 2AlCl_3 + 3\ Be$ and then volatilize the $AlCl_3$. From calculations of the heats of reaction and vapor pressures, the process should be practical at 200°-300°C. and should be almost quantitative without loss of $BeCl_2$. 9 references. CEM (2a)

Investigation of the Reduction of Beryllium Chloride with Metallic Aluminum (Untersuchungen über die Reduzierbarkeit von Berylliumchlorid mit metallischem Aluminium) Hellmut Fischer & Newton Peters. *Metall und Erz,* Vol. 30, Oct. 1933, pages 390-391. The process proposed by Kangro (see *Metallwirtschaft,* Vol. 30, page 389) was tried out in the laboratory using excess $BeCl_2$ in an atmosphere of H. At 260°C., the yield of Be was 12-17% of the theoretical and at 350°, 30-40%. At 450°, the excess $BeCl_2$ was volatilized. In the dark powder remaining, 80-90% of the Be was in the form of oxide, not metal, probably oxidized by O in the H. Metallic Be forms at 260°-350°, and gives a high yield at 350°. The Be is so finely divided and dispersed that it reacts immediately with air and moisture. The process is not practical. CEM (2a)

The Treatment of Waste from Silver Manufacture. Ernest A. Smith. *Metal Industry,* London, Vol. 43, Dec. 29, 1933, pages 627-629; Vol. 44, Jan. 5, 1934, pages 6-8. The recovery of metal from the wastes in the manufacture of Ag ware and in the electroplating industries is discussed. The best method is to send metallic waste directly to the smelters. The treatment of old plating solutions by electrolytic and precipitation methods is discussed. Ha (2a)

Device for Preparation of Alloys with Very High Melting Point (Vorrichtung für die Herstellung hochschmelzender Legierungen) F. Beck. *Zeitschrift für technische Physik,* Vol. 14, Nov. 12, 1933, pages 554-556. Device for electric sintering in vacuum of Re with Pt, Rh and Ir is described; compressed powders of the substances are placed between 2 W-contacts. Ha (2a)

Technical Production of Rhenium and Gallium (Die technische Gewinnung von Rhenium und Gallium) W. Feit. *Chemische Apparatur,* Vol. 20, Dec. 10, 1933, pages 183-184. The Cu slate deposits of Mansfeld (Prussia) contain 2×10^{-7}% Re, and still less Ga; some other heavy metals besides Cu and Fe are present in traces. Re is extracted as water-soluble perrhenates; metallic Re is made by reduction of K perrhenate by H at red-heat; it dissolves readily in H_2O_2. Its present use is mainly as a catalyser; alloying with rare metals seems promising. Thermocouples of Pt-PtRe combine high thermoforce with constant e.m.f. in the range of its application. Ga is produced as Ga_2O_3 and as metal by electrolysis from alkaline solutions. It is used for thermometers up to 1000°C. and more; as non-toxic amalgam it will prove useful for dentistry. At present 150 kg. Re and 60 kg. Ga can be produced per year; the price of Re is about 14000 M./kg. and Ga 10000 M./kg. Ha (2a)

Ferrous (2b)

Determination of the Dust Content of Fresh and Spent Gases in Metallurgical Use (Bestimmung des Staubgehaltes von Frisch- und Abgasen des Eisenhüttenbetribes) F. Lüth & K. Guthmann. *Archiv für das Eisenhüttenwesen,* Vol. 7, Dec. 1933, pages 343-351. Various methods of determining the dust content of gases are reviewed. By separating the dust into coarse and fine particles, precise analytical results can be obtained. A detailed description of the apparatus and procedure for this and for simpler methods are given. 22 references. SE (2b)

The Follsain Process. Treatment of Iron Ore and Blast Furnace Flue Dust. *Iron & Coal Trades Review,* Vol. 126, June 16, 1933, page 936. Fe_2O_3 is reduced to Fe_3O_4 rapidly by CO at about 800°C. in a relatively short rotary furnace. Fe ore of proper size is mixed with fuel, preferably coke dust; flue dust can be added to the ore. A few French and English installations are described briefly; Mn-containing Fe ores also can be treated. Costs per ton are approximately 1.5 d. for labor, 8 d. for fuel, 0.5 d. for power (5.5 kw.hr.) and 3 d. for maintenance and repairs. Ha (2b)

Pyrites Processing in the Dwight-Lloyd Plant. H. E. Woisin. *Metallgesellschaft,* No. 8, Jan. 1934, pages 25-28. (In English.) Roasting of pyrite is an exothermic process, while agglomeration is endothermic. Their combination gave economical heat utilization. A mixture of roasted and crude pyrite containing about 12% S could be reroasted without difficulty to yield a solid and porous agglomerate containing less than 0.2% S. The operation of a plant is described. Costs are reduced considerably from standard practice. Ha (2b)

Reduction of Iron Ores by Hydrogen and Carbon Monoxide (Die Reduktion von Eisenerzen mit Wasserstoff und Kohlenoxyd) F. Wienert. *Archiv für das Eisenhüttenwesen,* Vol. 7, Nov. 1933, pages 275-279. The progressive reduction of pieces of pure hematite and of ordinary hematite ore by H_2 and CO was followed by microscopic examination of sections. At temperatures below 570°C., reduction with H_2 proceeded uniformly from the surface inward; at higher temperatures reduced spots began to appear throughout the sample; the latter occurred on reduction by CO at all temperatures. At 650°C., a firm layer of reduced Fe surrounded the core of Fe_2O_3, so that further reduction by the diffusion of H_2 and CO through the outer layer could not take place readily. Reduction is favored by a porous structure; for this reason relatively dense Fe_3O_4 is not easily reduced. SE (2b)

Fanning—A New Technique in Blast Furnace Control. *Steel,* Vol. 92, Jan. 2, 1933, page 86. Reviews progress in blast-furnace operation during 1932. MS (2b)

Recent Developments in Construction and Operation of Blast Furnaces in the United States (L'évolution récent de la construction et de la marche des hauts fourneaux aux Etats-Unis). *Génie Civil,* Vol. 102, 1933, pages 513-515; *Iron & Coal Trades Review,* Vol. 126, May 5, 1933, pages 688-694; *Electrical Review,* Vol. 112, May 5, 1933, pages 632-633. Abstract of paper by W. A. Haven read before the Iron & Steel Institute, May 1933. See *Metals & Alloys,* Vol. 4, Nov. 1933, page MA 371. JDG + Ha + MS (2b)

Water-Cooling of Blast Furnaces (Wasserkühlung des Hochofens) B. v. Sothen. *Stahl und Eisen,* Vol. 53, Jan. 26, 1933, pages 85-91; Feb. 2, 1933, pages 121-125. Replies to a questionnaire on water-cooling of blast furnaces sent to German blast-furnace plants are summarized. The total H_2O consumption was 0.2-1.8 $m.^3/m.^2$ hearth surface, or 10-35 $m.^3$/ton pig Fe. Distribution to hearth, bosh, and other parts varied widely. The amount of heat carried away by the water was 100,000-460,000 cal./ton pig Fe. More adequate design with proper consideration of the laws of flow and transmission of heat will lead to more uniform and economical results. Hap (2b)

Centrifugal Machine Removes Molten Iron from Blast Furnace Slag. *Steel,* Vol. 92, Feb. 20, 1933, page 24. Edgar E. Brosius, Inc., has developed a machine which consists of a centrifuge mounted on a vertical motor inside of a retaining shell equipped with H_2O sprays for granulating the Fe-free slag as it leaves the lip of the pot. MS (2b)

MELTING, REFINING & CASTING (3)

Sand Testing in the Foundry. *Foundry Trade Journal,* Vol. 49, July 20, 1933, page 38. Material abstracted from paper presented to the Polish Foundrymen's Association by W. G. Buchanan, and dealing particularly with methods for determining density, green strength, and permeability. OWE (3)

Synthetic Foundry Sand. *Iron & Steel of Canada,* Vol. 16, Sept.-Oct. 1933, pages 99-100. Description, with 2 photographs, of properties of Canadian Kaolin Silica Products, Limited, manufacturers of synthetic foundry sands, at Lac Remi, Quebec. OWE (3)

Cylindrical Loam Cores (Noyaux Cylindriques en Terre) M. Vandendries. *La Fonderie Belge,* Vol. 2, Oct. 1932, pages 197-198; Dec. 1932, pages 239-241. Methods for sweeping loam cores vertically are explained. Devices and tools used are described. FR (3)

Gases in Metals. E. E. Schumacher. *Bell Laboratories Record,* Vol. 12, Sept. 1933, pages 17-20. The importance of having gas-free metals is pointed out; a few 1000th percent reduce magnetic and electric properties of Fe and Cu. A method of melting in vacuum and exhausting the gases is described. Ha (3)

The Foundry Sands of the Midlands. J. G. A. Skerl. *Iron & Steel Industry & British Foundryman,* Vol. 6, Mar. 1933, pages 209-210, 213. Abstract of a lecture and discussion. The Midland sands have 2 forms of bond, a mobile bond which is easily removed by washing, and a static bond which is permanent in the sand. The latter contributes most to bonding quality of the sand. Points relative to sand permeability, porosity and moisture content and the effect of milling time on properties of sand are discussed briefly. CHL (3)

Green-Sand Cores. Frank Whitehouse. *Iron & Steel Industry & British Foundryman,* Vol. 6, Sept. 1933, pages 399-401. Describes applications of green-sand cores to intricate molding and emphasizes their advantages. Their use has been limited more than necessary since, for certain purposes, they are the equal of dry-sand cores. CHL (3)

The Strength of Grey-Iron. A. C. Vivian. *Foundry Trade Journal,* Vol. 49, Aug. 31, 1933, pages 117-119. Author has analyzed a number of records of tests on cast iron and has evolved therefrom a method of correlating tensile and transverse strengths on a theoretical basis. This method has been applied to comprehensive series of tests which were referred to by F. C. Edwards in the *Foundry Trade Journal* for March 19, 1931, and satisfactory agreement between the theory evolved by the author and Mr. Edwards' results was obtained. OWE (3)

Colbond in the Foundry. J. Thompson. *Foundry Trade Journal,* Vol. 48, June 15, 1933, page 417. A description of the effects produced by a recently discovered bonding clay, mined in the British Isles, and possessing a higher plasticity than most clays. This material is marketed under the name "Colbond." A number of examples are given of the effect of adding "Colbond" to sands, upon their permeability, etc. OWE (3)

Making of a Cylindrical Core Box by Means of the Circular Saw (Confection d'une Boite à Noyau cylindrique au Moyen de la Scie circulaire) Try-Chalons. *Révue de Fonderie Moderne,* Vol. 27, Mar. 25, 1933, pages 94-95. Describes a simple method. Ha (3)

Segregation (Untersuchungen über Seigerung) G. Masing & E. Scheuer. *Zeitschrift für Metallkunde,* Vol. 25, Aug. 1933, pages 173-179. A review. See also *Metals & Alloys,* Vol. 4, July 1933, pages 99-104 and Aug. 1933, pages 109-111. RFM (3)

Construction of Loam Cores (Noyautage de Formes en Terre) A. Philippart. *La Fonderie Belge,* Vol. 3, June-July 1933, pages 94-96. Account of the work of the technical committee of the Belgian Foundrymen Association. Examples of construction of several kinds of loam cores are given. FR (3)

New Methods of Sweep Molding (Neue Wege in der Schablonenformerei) *Zeitschrift für die gesamte Giessereipraxis*, Vol. 54, Sept. 3, 1933, pages 364-366. Description of a sweep molding device distinguished by simplicity and flexibility. An essential advantage is the rigid guide of the sweep arm around the spindle and automatic lowering device of sweep. Use of the new device is discussed. Special devices have been developed for molding by sweep piston rings and similar parts that are difficult to make by other sweep molding methods. Advantages of new devices are compared with former methods. GN (3)

Notes on Sand Analysis. *Sands, Clays & Minerals*, Vol. 1, July 1933, pages 62-63. Analysis of sand should be carried out with the intended use in mind, i.e. whether it is used for glass industries, in steel making or for foundry purposes; for the latter use, the presence of lime and magnesia must be carefully determined. Method of analyzing by fusion is briefly described. Ha (3)

Non-Ferrous (3a)

G. L. CRAIG, SECTION EDITOR

The Casting of Aluminum (La fonderia d'alluminio) C. Panseri. U. Hoepli, Milan, 1934. 6¼ x 9¼ inches, 582 pages. Price, L. 65. This is another of the good metallurgical books written by Italian authors and published by Hoepli to give Italian technicians up-to-date information in their own language.

Though the bulk of the volume covers the metallurgy, metallography and testing of aluminum casting alloys, it also contains much for the practical foundryman. Perhaps the discussion of heat-treatment for precipitation-hardening is a bit too sketchy to convey full understanding of the subject, and the section on aluminum pistons does not cover some of the finer points.

On the whole, the book is an excellent summary. Since the material is available in English, the chief interest of American readers will be in the compilation of the specifications of various countries and the information on the composition and properties of many trade-named alloys.

The references are very complete, being brought up through Oct. 1933, though the book was in the reviewer's hands the middle of January. This is rapid book-making. The type, paper and illustrations are all very attractive.

H. W. Gillett (3a)-B-

The Casting of Brass Ingots. R. Genders & G. L. Bailey. British Non-Ferrous Metals Research Association, London, 1934. Cloth, 6¾ x 10 inches, 191 pages. Price 15s. 6d. Some 14 year's work on casting of strip ingots of 70/30 brass is summarized. The sources of the various possible defects have been exhaustively studied. The macrostructure under different conditions of pouring, porosity due to shrinkage and inclusion of gas bubbles, surface condition due to composition, mold material and design, and to the surrounding atmosphere, effect of casting temperature, of mold dressings, rate of pouring, etc. are all discussed in detail on the basis of extensive tests made to show the effect of one variable at a time.

The 70/30 brass is considered not to evolve dissolved gas as do those of lower Zn content. The gas holes are laid to hydrogen and hydrocarbons from the mold dressing, and a method of pouring through a blanket of city gas was worked out which avoids the need for volatile mold dressings. Copper molds, with or without water-cooling are strongly advocated, though a possible competitor may be the Erichsen "Erical" method in which a mold is used whose thin side walls, of a low conductivity Fe-Ni alloy, expand under the heat of the casting and exert pressure on the solidifying metal.

Some of the defects to which straight 70/30 is prone are minimized by changing the composition to 76/22 with 2% Al. This demands casting by the Durville process.

Very much improved surface is obtained by the addition of 0.05% P to the 70/30 brass, without much effect on the mechanical properties or the workability. The hardness of the annealed brass is raised, as is the annealing temperature.

The experimental work, which was carried out in the laboratories of Woolwich Arsenal for the British Non-Ferrous Metals Research Association, is of extremely high grade, both in planning and execution. The monograph is well printed and bound.

The work is a good example of the important fundamental information that can be collected by joint effort over a sufficient period of time. The purpose was eminently practical, to show how to produce ingot that will roll to strip with a minimum of rejection. The work is described so simply and clearly that melters and casters or non-technical executives will have little difficulty in following the argument and putting the findings into practice.

It is especially interesting as an example of joint effort in the field of production methods, a matter on which cooperative attack is not often considered feasible in this country. Yet if this sort of thing could be done in relation to the problems of the makers of heat-resisting alloys, to pick an example at random, it might well prove more economical than less complete work, with much duplication, done by each individual foundry. H. W. Gillett (3a)-B-

Notes on Electrolysis of Copper (Note sur l'électrolyse du cuivre) E. Vuigner. *Journal du Four Electrique*, Vol. 42, Oct. 1933, pages 363-367. For best efficiency anodes must be pure, analysing 99.50 Cu or at least 99.25 Cu which can be obtained by proper melting and poling. Cathodes should be prepared with pure electrolytes and using about one half of the current density of the usual process. The temperature of the baths should always be kept sufficiently high. Chlorine or colloids should not be added. JDG (3a)

On the Deoxidizing Effect of Phosphorus in Copper Alloys (Wie ist die Wirkung des Phosphors als Desoxydationsmittel bei Kupferlegierungen?) E. T. Richards. *Zeitschrift für die aesamte Giessereipraxis*, Vol. 54, Oct. 29, 1933, pages 454-455; Nov. 12, 1933, pages 471-473. Difficulties occasionally encountered in using P or P-Cu respectively as deoxidizer are considered. Author discusses his experiences in deoxidizing and casting (1) bronze rings, (2) gun barrel bronze for gears, (3) heavy castings with 80% Cu, 10% Sn and 10% Pb, (4) automobile bevel gears, (5) condenser tubes, (6) malleable brass containing 42% Zn, 2.5% Fe, balance Cu. In summarizing author states that P is best deoxidizer, however, in order to obtain sound castings, metal should contain not more than .02% P, if possible only traces of P. P above this amount acts as alloying constituent, therefore being favorable only in certain alloys and for certain purposes. Methods of deoxidation with P-Cu are finally considered. P-Cu should be so added that all parts of a melt have intimate contact with the deoxidizer. P-Sn should not be used for deoxidizing bronzes since it melts too rapidly to insure complete deoxidation. GN (3a)

Cooling of Ingots in Chill-Molds, in Particular of Brass Ingots in Water-Cooled Molds (Ueber die Abkühlung von Blöcken in Kokillen, insbesondere von Messingblöcken in wassergekühlten Kokillen) Walter Roth. *Die Giesserei*, Vol. 20, Sept. 15, 1933, pages 413-419. Formulas are developed which permit the determination of the temperature distribution in ingots in water-cooled molds during cooling, temperature differences in the block, cooling velocity and heat consumption of the cooling wall. By proper selection of material and thickness of the cooling wall the duration of solidification of brass ingots can be varied up to 50% while changing the flow of cooling water gives only 15%. 70/30 brass freezes, under rapid cooling, not within one definite temperature interval according to the Cu-Zn diagram but at a constant temperature; this results in a very small *demiscibility*. Grain size and transcrystallization of brass castings depend mainly on casting and cooling velocity. The small change of rate of cooling possible in chill-molds changes the structure but slightly, the casting temperature exerting the greatest influence. Ha (3a)

Ferrous (3b)

C. H. HERTY, SECTION EDITOR

Removal of Phosphorus, Sulphur and Oxygen in Quality Steel Production in the Basic Open-Hearth (Die Abscheidung von Phosphor, Schwefel und Sauerstoff bei der Qualitätsstahlerzeugung im Siemens-Martin-Ofen) F. Beitter. *Stahl und Eisen,* 1
Vol. 53, Apr. 13, 1933, pages 369-375; Apr. 20, 1933, pages 398-404. Using 40 ton basic open-hearth furnaces, frequency curves of P, S, and O_2 removal for a large number of heats of C steel were determined. In heats which were not ored down the P removal was somewhat better than in ored heats; this was attributed to the temperature rise on oreing. Remelting of heats by pouring them back from the ladle into the furnace resulted in appreciable S removal. Addition of 180-200 kg. of strontianite to a 40-ton heat, preferably to the bare bath, also caused a decided S removal. City-gas gave lower S heats than producer gas. Oreing down tended to hinder S removal. A high C and Mn melt down, reducing flame, and high temperature aid desulphurization. Vacuum fusion oxygen analyses gave lower values for acid than for basic steel. Examples are given of the 2
effect of type of scrap, condition of the hearth, and alloy additions on the rate of C drop. Suggested optimum rates of C drop are indicated. SEp (3b)

The Physico-chemical Basic Laws of Metal-Slag Equilibrium (Die physicochemischen Grundgesetze des Metall-Schlacke Gleichgewichts) Friedrich Körber & Willy Oelsen. *Archiv für Eisenhüttenwesen,* Vol. 6, Feb. 1933, pages 307-314. The metallurgical reactions of industrial methods of steel production are considered as chemical transformations in a heterogeneous system of many constituents; the total course of the reaction is principally determined by the reactions between the 2 liquid phases, melt and slag. The investigation of the equilibrium between these 2 phases leads to the development of rules for the production of pure metals many of which are already practically used. Every metal must 3
be separated very thoroughly from its base metallic impurities if it is melted in one of its salts at the lowest possible temperature, but from the rarer impurities only at very high temperature. Application of the ideal and the general mass law to the equilibria of metallurgical reactions and the calculation of the reactions and heats of formation is explained briefly and exemplified for the case of steel. Ha (3b)

Fluidity of Slag and the Processes of Refining Steel (La fluidita della scoria e i processi di affinazione dell'acciaio) L. Losana. *La Metallurgia Italiana,* Vol. 25, June 1933, pages 405-414. Viscosity measurements have been made on slags from both acid and basic Martins, as well as electric furnaces. The viscometer consists of a graphite rod rotating in the molten slag under the impetus 4
of a definite weight, while a needle registers on a horizontal scale. The distance this needle moves in a certain time is a measure of the viscosity. The basic slag had the composition, CaO 43, Al_2O_3 7, SiO_2 50%, with M.P. 1440°, and viscosities at 1500° 7.1, 1600° 6.3, 1650° 5.1, 1700° 3.5. These values are compared with that of water at 20°. In a first series, the effect of adding FeO and Fe_2O_3 (from 3.95-28.94%) was measured. Increasing the iron oxide increases the viscosity at 1500° from 3.0-6.3, and at 1700° from 1.2-2.8. Replacing Fe with MnO does not affect the viscosity appreciably up to 15% MnO, but at higher Mn contents it increases with increasing MnO. Viscosity of commercial slags was also measured. It was noted that slags with high FeO and low CaO have a higher viscosity than when the CaO is also high. This may be due to a very basic silicate such as 3FeO. SiO_2, decomposing to give FeO and 2 FeO.SiO_2, or even FeO.SiO_2. 5
With higher CaO, the SiO_2 is combined with both, and only FeO.SiO_2 which is stable at the higher temperatures is formed. The effect of adding varying amounts of fluorspar having the composition, CaF_2 92.64%, $CaCO_3$ 2.96, H_2O 4.01, Fe_2O_3 0.36% was measured. The viscosity drops in all cases with additions up to 5% fluorspar, but at 10% the viscosity again rises, except when high SiO_2 is present, when it drops lower. Therefore, there is an optimum amount of fluorspar, which increases as the % of SiO_2 in the slag increases. AWC (3b)

Melting Steel in the Cupola (La Fusion de l'Acier au Cubilot) G. D'Ardigny. *Revue de Fonderie Moderne,* Vol. 27, Aug. 10, 1932, pages 219-222. The production of low C iron in the cupola furnace and the recent progress made are discussed. In order to obtain a melting point of the steel added to the charge 6
which is sufficiently low for the cupola furnace the steel is first carburized or cemented by contact with coke or the hot combustion gases. Rusty scrap with high S content should be avoided in the charge. Si stabilizes the carbonization of the steel scrap; scrap coming from old railway or automobile springs with about 1.5% Si gives excellent results. Methods of casting ingots and remelting are discussed, the addition of ferro-chrome is recommended to obtain dense grain; 0.3-0.4% Cr is sufficient, the melting temperature is 1200°-1250° C. Ha (3b)

Technology of Alloy Steels (Die Technologie des Edelstahles) Alfred Kropf. Wilhelm Knapp Verlag, Halle (Saale), 1934. Paper, 6⅛ x 9½ inches, 264 pages. Price 11.50 RM. Commercial alloy steels are described, in rather general terms, in 100 pages. Melting, casting and working down from the ingot occupy 7
35 pages, heat-treatment 50, testing 40, and discussion of defects 10. With so broad a field to cover, no subject can be gone into very deeply. Some of the points of interest are photos of fractures of many of the steels discussed, a list of the German, English, Swiss and U. S. (S.A.E.) standard steels, and a list of the trade names of the alloy steels put out by 10 German firms, classified as to approximate composition. The volume is indexed. H. W. Gillett (3b)-B-

Melting Gray Iron in the Crucible. Willard H. Rother. *Foundry,* Vol. 61, Apr. 1933, pages 16, 50. Melting small heats of cast Fe, crucible melting in an oil fired tilting furnace meets this problem well and at a nominal cost. For melting ordinary cast Fe a silicon carbide crucible is recommended. Gives results of a test heat. VSP (3b) 8

Basic Open-Hearth Bottom-cast Practice and Iron-oxide Control. W. J. Reagan. *Metals Technology,* Jan. 1934, *Technical Publication* No. 520, 15 pages. Bottom-casting practice is discussed and it is claimed that it is commercially practicable and allows production of ingots free from cracks and excessive pipe. Basic open-hearth ingots comparatively free from non-metallic inclusions can be produced. Inclusion analyses of several ingots are shown. The control of O content during manufacture is discussed and data are given to prove that control can decrease scrap loss, increase Mn efficiency, and produce a better product. JLG (3b)

Is a large quantity of Scrap in Charges Economic? (Ist hoher Bruchzusatz wirtschaftlich?) Carl Rein. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 54, Oct. 1, 1933, pages 401-402. In recent times use of a high share of 9
scrap in cupola melting has been proposed. Detrimental effect of decreased Si content shall be counteracted by addition of ferrosilicon, enrichment in S by desulphurization in forehearth or ladle. Author shows by calculations that melting with high scrap amount is uneconomic, furthermore high quality cast Fe cannot be obtained by this method. GN (3b)

Processing of Rings for Advertising Pillars (Die Herstellung von Plakatsäulenringen) A. Freitag. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 54, Dec. 10, 1933, pages 515-517. For 3 different rings author discusses in detail processing of patterns, making of molding flasks, molding and casting, including chemical composition of material. GN (3b)

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Prevention of Porosity in Castings John A. Smeeton. *Foundry Trade Journal,* Vol. 48, June 22, 1933, pages 425-426. An article describing what are referred to as "Perfect" cooling spirals which have been devised to increase the rate of cooling in such parts of iron castings as would be rendered porous by prolonged cooling. The article is accompanied by 5 illustrations. OWE (3b)

Synthetic Manufacture of Malleable Iron Castings in the Cupola Furnace from Mixtures containing Much Scrap but Without Malleable Raw Iron (Die Synthetische Herstellung von Kupolofentemperguss aus schrottreichen Gattierungen ohne Temperroheisen) RUDOLF STOTZ. *Die Giesserei,* Vol. 20, Aug. 4, 1933, pages 321-324. Use of large amounts of steel scrap in mixing often leads to difficulties in melting
1 and pouring. In mixing the ingredients exactly according to the desired materials and melting in a cupola furnace a very economical and especially uniform product can be produced when employing wrought-iron scrap of proper composition and amount. Differences in the contents of C, Si and Mn for different castings were only about 0.04-0.08% by this method, while the old method showed differences from 0.07 to 0.24%, in the percentage of the constituents. The tensile strength of the material is 40-50 kg./mm.^{2} with an elongation of 8-5%, and 5-30 M. were saved per ton of good material. This method is of particular value for heavy as well as thin pieces. Ha (3b)

Economical Operation of the Cupola; Old and New Performances (La Conduite Economique du Cubilot Experiences Anciennes et Recentes les Performances du
2 **Cubilot)** E. RONCERAY. *Bulletin de l'Association Technique de Fonderie,* Vol. 7, Aug. 1933, pages 306-316; *Revue Fonderie Moderne,* Vol. 27, June 10, 1933, pages 161-167. Study of cupola operation. If one gives the same attention to cupola melting as is given to other furnace operations excellent results in economy and quality of metal may be obtained. Good metal may be obtained with 7.5% of coke between charges. Ha + WHS (3b)

Charging Devices for Electric Furnaces (Dispositifs de Chargement des Fours Electriques) H. REDENZ. *La Revue Industrielle,* Vol. 63, July 1933, pages 352-354. A summarized translation from *Stahl und Eisen.* See *Metals & Alloys,* Vol. 4, July 1933, page MA 221. FR (3b)

Continuous Operation in Steel Foundries (Beitrag zur Frage der Einrichtung der
3 **Fliessarbeit in Stahlgiessereien)** H. NIEDT. *Die Giesserei,* Vol. 20, May 12, 1933, pages 189-193. The possibility of economical operation of a steel foundry with continuous conveyors (like the Ford system) is discussed and thorough investigation of concrete examples lead to the conclusion that, in general, this mode of working is not the best for steel foundries. For the different processes are suggested: telpherways for molding and casting, conveyors for molding sand, suspension trolleys for transporting and pouring of molten steel, and electric trucks for transportation of empties, cores and castings to the different places of working. The layout of the foundry with above points in view is described. Ha (3b)

Some Experiences with the Balanced Blast Cupola. H. H. SHEPHERD. *Iron & Steel Industry & British Foundryman,* Vol. 6, Jan. 1933, pages 147-149; Feb. 1933, pages 183-186, 188. See *Metals & Alloys,* Vol. 4, Oct. 1933,
4 page MA 332. CHL (3b)

Molding and Casting of a Pulley (Formen und Giessen einer Seilscheibe.) F. VOGELSANG. *Die Giesserei,* Vol. 20, Sept. 1, 1933, page 377. Describes procedure. Ha (3b)

Preheating of Airblast in the Cupola Furnace (Le Réchauffage du Vent Soufflé au Cubilot) TRY-CHALONS. *Revue de Fonderie Moderne,* Vol. 27, Nov. 25, 1933, pages 316-318. It is shown how by preheating the airblast in cupola furnaces output can be increased; instead of only 8 to 9 kg. of metal, 12.25 kg. for each kg. of burnt coke can be melted, and about 1/3 air less is required for each ton of metal as the amount of air required per kg. of coke remains the same. This, in turn, reduces again oxidation of the metal in the charge. Ha (3b)

5 **Sulphur in the Operation of a Cupola Furnace (Der Schwefel im Kupolofenbetrieb)** IW. TRIFONOW. *Die Giesserei,* Vol. 20, Nov. 10, 1933, pages 497-500. The influence of the different kinds of S in the coke on the melting of raw Fe in the cupola was investigated. Raw Fe can be sulphurized in the cupola in the liquid state only (drops, melt). A harmful influence is exerted only by the "organic" S and Fe-sulphide S which form together the so-called combustible S of the coke. The non-combustible S bound to calcium sulphide is harmful only in an oxidizing melt and if not sufficient lime is present as it reacts readily with ferrous oxide but not with metallic Fe and can be rendered harmless by greater amounts of "free" lime or Mn. This explains the often made observation that the "non-combustible" S in the coke does not deteriorate the quality of the casting even
6 if it is present in excess both for proper amounts of coke and too much coke in the cupola furnace. Ha (3b)

First Report of the Steel Castings Research Committee. A COMMITTEE OF THE IRON AND STEEL INDUSTRIAL RESARCH COUNCIL. *Foundry Trade Journal,* Vol. 48, May 25, 1933, pages 361-362; June 1, 1933, pages 379-390; June 8, 1933, pages 403-404. This report discusses the variety of defects encountered in steel castings and their influence, with special reference to results of an examination of typical castings weighing 170-9,000 lb. made in the course of ordinary manufacture. Information obtained as a result of these tests, regarding blowholes, shrinkage cavities, hot cracks, etc., is given in detail. An attempt to determine the causes and remedies of these defects involved the production of 16
7 castings of medium size (about 280 lb.) made to the same design but produced under varying conditions, the variables being defined as fully as possible in each case. The importance of the correct choice of the position of the casting in the mold and of the position of the runner was made evident. The effects of variations in the weight, area, and spacing of the heads, in the rate of filling the mold, and in casting temperature were determined. The application of these results to practice in general is dealt with. The paper closes with a discussion of what are termed: natural difficulties, depending on the physical properties of liquid and solid steel, design difficulties, and economic difficulties. OWEp (3b)

Bauxite as a Flux in the Basic Open-Hearth Furnace (Bauxit als Zuschlag im basischen Siemens-Martin-Ofen) F. H. SCHÖNWÄLDER. *Stahl und Eisen,* Vol. 53, Sept. 14, 1933, pages 949-952. Working 35-ton basic open hearth heats
8 with Hungarian (57-58% Al_2O_3) and German (40-46% Al_2O_3) bauxite, is stated to have indicated the following advantages of bauxite over fluorspar: the slag becomes thin more quickly, boils less violently, and allows more rapid heat transfer; the hearth and ladle brick last longer; bauxite is cheaper; there may be a removal of nitrides. In discussion an instance was cited where working with bauxite gave higher S in the steel; after continuous working with bauxite the hearth grew too thick. SEp (3b)

Steel and Slag Temperatures in Basic Open-Hearth Melts. (Ueber Stahl-und Schlackentemperaturen bei basischen Siemens-Martin-Schmelzungen) E. SCHRÖDER. *Stahl und Eisen,* Vol. 53, Aug. 24, 1933, pages 873-884. Bath and slag temperatures in a 100-ton open-hearth furnace were measured optically and with a
9 W-Mo thermocouple. The emissivity correction factors for the optical measurements were concluded to be 0.5 for the molten steel and 0.6 for the molten slag. In a quiet bath when no additions were being made the slag temperature was from 10° to 60° C. higher than that of the steel. After complete melting the temperature difference between the top and the bottom of a bath 100 cm. deep was found to be no more than 30° C. The total temperature drop from furnace to pouring platform was from 50° to 90° C. Since for good pouring the temperature should be from 50° to 80° C. above the melting point the total degree of superheat of the melt should on this account alone, therefore, be from 100° to 170°C. SEp (3b)

Killing of Steel, Particularly with Calcium-Silicide (Ueber die Beruhigung des Stahles besonders durch Kalzium-silizium) C. SCHWARZ. *Stahl und Eisen,* Vol.
10 53, Sept. 28, 1933, pages 1000-1003. On deoxidizing mild steel with a calcium-silicide alloy containing 1.2-1.6% C; 58-61% Si; 0.006-0.007% Mn; 29-31% Ca, instead of with ferro-silicon, smaller final additions of Al were needed to completely kill the steel. A more fusible inclusion seemed to result from the use of calcium-silicide, although alumina inclusions were not entirely eliminated. The cost of the calcium-silicide is not higher than that of ferro-silicon if the saving in Al is considered. SEp (3b)

The Study of Pourability of Cast Iron (Contribution a L'Etude de la Coulabilite des Fontes) R. BERGER. *Bulletin de l'Association Technique de Fonderie,* Vol. 7, Dec. 1933, pages 489-506; *L'Usine,* Vol. 42, Dec. 21, 1933, page 27; *La Fonderie Belge,* Vol. 2, Oct. 1932, pages 186-196; Nov. 1932, pages 210-222. Pourability or castability of a metal is defined as the facility with which it completely fills the mold; the principal factors are: temperature of metal in pouring, viscosity of the liquid metal at the pouring temperature and condition and shape of the mold. Cast irons with less than 0.5% Si improve their casting quality with increasing Si content; between 0.75 and 0.95% Si a sudden drop in castability occurs and from this point on castability improves gradually again until the Si content for the eutectic C concentration is reached; for higher Si contents castability again diminishes. The sudden drop is explained by an endothermal reaction which is due to the initial Si content from the pig iron, a "hereditary" phenomenon. The tests are described in detail by diagrams taken for both different C and different Si contents. The formula of Portevin considering all influences

$$A = \alpha \frac{cd\,(\theta - F)}{F - \theta_1} + \beta \frac{Ld}{F - \theta_1},$$

where A = castibility, α and β = coefficients depending on the nature of mold and viscosity of metal, d = density of metal, F = freezing temperature of metal, C = spec. heat of liquid metal, θ = pouring temperature, θ_1 = temperature of the mold, L = latent heat of freezing of the metal, represents fairly well the results obtained in the experiments. FR + Hap (3b)

The Production of Large Steel Castings. *Shipbuilder & Marine Engine-Builder,* Vol. 40, June 1933, page 312. A discussion on the relative steel technique in American, British and European foundries, indicates that there is much greater scientific control over all stages in the production of large steel castings in the latter foundries, than is characteristic of the foundries from which the U. S. Navy are in the habit of obtaining their castings. JWDp (3b)

Melting Methods for Alloy Irons. GARNET PHILLIPS. *Metal Progress,* Vol. 24, Sept. 1933, pages 35-41. The author makes 7 composition classifications of alloy cast iron, (1) Ni, (2) Cr, (3) Ni-Cr, (4) Ni-Cu-Cr, (5) Ni-Cr-Mo, (6) Ni-Mo, and (7) Mo. These may be further divided into carbon classifications, 3.20% to 3.35% C made in a cupola, electric furnace irons of total C 2.50% to 3.00%, and electric furnace iron of lower carbon than 2.50%. A wide variety of uses are mentioned bringing into play special properties such as wear and abrasion resistance, heat resistance, high strength at ordinary and elevated temperatures and ability to harden on quenching. Controlled melting practices are essential for the production of such irons of uniform properties. Cupola practice is controlled by proper selection of coke, close limits of composition on the pig iron and use of no foreign scrap in charges. Use of a forehearth or receiving ladle in connection with the cupola practice is described and the methods of alloy addition at the forehearth spout. Control tests for carbon content and depth of chill are made before pouring is started. Various chill and wedge test bars are described with the features observed. The utility of the electric furnace in the production of these irons is mainly as a supplement to the cupola to melt irons which on account of low C or other reasons are impractical to produce in the cupola. Superheating cupola iron in the electric furnace has not been found of value. Physical properties as obtained by transverse, tensile and hardness tests are tabulated for a number of cupola and electric furnace irons. WLCp (3b)

New Methods in Metallurgy (Nouvelles Methodes en Metallurgie) M. PERRIN, L. GUILLET & F. LEPERSONNE. *Revue Universelle des Mines,* Series 8, Vol. 9, Aug. 15, 1933, pages 441-442. Refining methods are reviewed with particular respect to the influence of speed of reaction, inclusions and slags. Although the reactions could have a high velocity at the refining temperatures they are slow because metal and slag in contact are almost in equilibrium so that the exchange of matter is slow and also the viscosity of the slag and the relatively small surface of the contact retards the reactions. The addition of deoxidizers to a steel bath containing FeO in solution causes formation of inclusions which will not usually float up completely. The steel should, therefore, be freed of the greatest part of O before the addition of deoxidizers. The division of FeO between metal and slag is a function of temperature. In basic slags, all FeO is free, while only a small part is free in acid baths. Effects of dephosphorization and deoxidation are explained; the latter is not such simple chemical process as the former. For very fine steels the usual deoxidation is not sufficient and can be improved by increasing the ratio of the solubilities of FeO between slag and steel bath, i.e. increase the acidity of the slag. Means to do this are discussed; this "electric Thomas" process has given excellent steels at lower cost and increased production. Hap (3b)

Indirect Rapid Determination of the Iron-Oxide Dissolved in the Open-Hearth Bath (Verfahren zur mittelbaren Schnellbestimmung des im flüssigen Siemens-Martin-Stahl gelösten Eisenoxyduls) H. SCHENCK. *Stahl und Eisen,* Vol. 53, Oct. 12, 1933, pages 1049-1052. Graphs are given showing how an increase in the FeO dissolved in the open-hearth steel bath causes an increase in the rate of C drop. From these graphs the amount of FeO dissolved in the bath may be approximated by determining the rate of C drop over a period of about an hour. It is brought out in discussion that although these calculated results are fairly accurate, they apply only to FeO in solution in the bath and when the rate of C drop is not too fast, and that they may be affected by the depth of the bath. SEp (3b)

Slagging, in Particular Desulphurization of Steel, in the Coreless Induction Furnace (Ueber die Durchführung von Schlackenarbeiten, insbesondere der Entschwefelung von Stahl, im kernlosen Induktionsofen) H. SIEGEL. *Siemens-Zeitschrift,* Vol. 13, Nov.-Dec. 1933, pages 338-341. The purpose of slagging is removal of undesirable and harmful constituents from the melt by converting them into a slag which is removed after completed reaction. Desulphurization goes on according to $FeS + CaO = CaS + FeO$. CaS is not soluble in the melt and can therefore be removed as slag. While in the electric arc furnace the melt is heated through the slag, which means that the slag is hotter than the melt, the slag is heated by the melt in induction furnaces and is therefore colder than the melt. The arc furnace liquefies therefore slags with high Ca content and can produce carbide by the arc. In the low-frequency furnace, desulphurization is effected by ferro-silicon which acts as reducing agent and also slag-forming, but while 15% fluorspar suffices in the arc furnace, more than twice this amount has to be used in the induction furnace. The induction furnace has, however, the advantage of greater movement in the melt so that reactions take place faster. In order to protect the lining against the slag with high fluorspar content desulphurization is carried out with alkalis, for instance according to $NaO_2 + FeS = Na_2S + FeO$; the alkali is applied as carbonate. Tests are described which gave very satisfactory results and suggestions made for practical operation of this method. Hap (3b)

Measurements of the Heat Contents of Steel and Slag. (Messungen des Wärmeinhaltes von Stahl und Schlacke) E. SCHRÄDER. *Archiv für das Eisenhüttenwessen,* Vol. 7, Sept. 1933, pages 157-164. The heat contents of basic-open hearth steel and slag between 1500 and 1700° C. were determined calorimetrically and the results compared with previously published data. The use of a practical calorimeter for measuring molten steel and slag temperatures is suggested. SE (3b)

Making Manganese Steel Castings in an Electric Furnace (La fabrication des moulages d'acier électrique au manganese au four électrique) E. SALOMON. *Journal du Four Electrique,* Vol. 42, Sept. 1933, pages 324-326. Generalities. JDG (3b)

Manganese and Phosphorus Equilibria in the Open-Hearth Furnace in the Light of Newer Temperature Measurements Part II. (Das Mangan- und Phosphorgleichgewicht im Siemens-Martin-Ofen im Lichte neuerer Temperaturmessungen. II.) C. SCHWARZ. *Archiv für das Eisenhüttenwesen,* Vol. 7, Oct. 1933, pages 223-227. The formulae given in Part I are verified and extrapolated to slags of higher P_2O_5 content. Three nomograms used in the calculations are illustrated. SE (3b)

WORKING (4)

Rolling (4a)

RICHARD RIMBACH, SECTION EDITOR

Manufacture of Strip Tin-Plate (Herstellung von Weissband) W. Krämer. *Stahl und Eisen*, Vol. 53, Nov. 30, 1933, pages 1237-1240. Numerous advantages, mainly economic but also technical, of strip steel over sheet for tin plate are listed. A very complete and detailed account of the rolling and processing of strip steel into tin plate is given. The whole process is continuous, the coiled strip being cut up into short lengths only after the tinning operation. SE (4a)

Prevention of Sticking in Hot Rolling of Fine Sheets (Vermeidung des Klebens beim Warmwalzen von Feinblechen) J. Gergen. *Stahl und Eisen*, Vol. 53, Jan. 5, 1933, pages 18-19. The reason for sticking of sheets in hot rolling is often due to the surfaces not being clean, but the chemical composition plays a considerable part. Material with high C, Mn, P and Cu is much less liable to stick than a material with low content of these elements. It can be prevented to a great extent by careful and scale-free heating of the sheet packs. For sheets of large dimensions, 1060x2400x0.5 mm. or thereabouts, or sheets of particularly soft material, to be finished in packs of 4 to 12 sheets it is recommended that after doubling the packs should not be put into the finishing furnace but first pickled in dilute H_2SO_4 66° Bé, and then placed in the furnace. After this they are hot-rolled. Pickling is done best in baskets in which the folded sheets are placed so that the open side of the fold points upward which facilitates easy and uniform action. Although this process increases the production costs, the greater output because of less waste is said to compensate easily for it. Ha (4a)

Rolling Mills with Very Thin Work Rolls (Walzwerke mit sehr dünnen Arbeitswalzen) *Zeitschrift Verein deutscher Ingenieure*, Vol. 78, Jan. 6, 1934, pages 28-29. Steel and Ni were rolled down to 0.01 mm. and Cu to 0.007 mm. on roll stands with 12 rolls; the work rolls had a diam. of 8-10 mm. and a length of 80 mm., and were supported by 2 intermediary rolls each of which were again supported by 3 outer actual supporting rolls. Another stand had work rolls of 30-40 mm. diam. with 320 mm. length, the intermediary rolls 85 mm. and the supporting rolls 165 mm. diam. Openhearth steel strip with 0.07% C, 0.95 mm. thick and 200 mm. wide, and annealed was rolled down in this stand to 0.45 mm. in the first pass, to 0.22 mm. in the second, 0.11 in the third and 0.07 mm. in the 4th pass without intermediary reheating. Strips of 0.005 mm. were rolled on a 20-roll housing; the work rolls had 3.5 mm. dia. and had 2 intermediary rolls each which were supported by another 3 larger intermediary rolls and these finally by 4 large supporting rolls. These rolling mills are in operation at Heraeus Vacuum Melting Co., Hanau (Germany). Ha (4a)

Analysis of Factors Influencing Rolling Pressure and Power Consumption in the Hot Rolling of Steel. Sven Ekelund. *Steel*, Vol. 93, Aug. 21, 1933, pages 27-29; Aug. 28, 1933, pages 44, 46; Sept. 4, 1933, pages 38, 40-41; Sept. 11, 1933, pages 32, 34; Sept. 18, 1933, pages 29-32; Sept. 25, 1933, pages 71-74; Oct. 2, 1933, pages 45-46, 48. Translated by Bengt Blomquist from *Jernkontorets Annaler*, 1927. By a theoretical analysis of the dynamics of the rolling process, derives formulas for rolling force, torsional moment, and power consumption, which are claimed to be the most reliable yet published for ordinary grades of steel. All influencing factors are considered. Tests were run on a 28-in. 2-high reversing mill with plain rolls to check a number of the steps in the calculation and to study the problem from a practical point of view. Concludes that there is no difference in principle, relative to distribution of forces, between compression of the material by curved roll surfaces or by plane, parallel surfaces. Horizontal forces due to friction are directed opposite each other and are in equilibrium at a point on the front part of the surface of contact. Compression takes place around this point, its location governing the movement of the material relative to the roll. Material will move more slowly than the roll, causing slippage opposite to the direction of rolling, in the zone of contact up to this point, and more rapidly than the roll, causing slippage in the direction of rolling, in the area in front of this point (direction of rolling being considered as the forward direction). Rolls act upon the material only by pressure. Course of internal deformation was followed by assuming plane parallelepipedal compression in combination with frictional influence. Actual compressive strength of the material is obtained by multiplying the "ideal" strength, including the effect of velocity, by a friction factor. Spreading is determined directly from the frictional forces, knowing the distribution of forces, the point of application of the rolling force and the torsional moment were determined because the rolling force is directed vertically. Compressive strength and the constant of viscosity were determined, as functions of the temperature and of the composition of the rolled material, by applying the derived formulas to available data on the rolling work and rolling force. Formulas are valid for all of the ordinary pass sections. MS (4a)

Rockrite seamless tubing (Tubi senza saldatura "Rockrite") G. Porro. *La Metallurgia Italiana*, Vol. 25, Dec. 1933, pages 889-893. A description of the process of manufacture of "Rockrite" seamless tubing by the Tube Reducing Corporation. AWC (4a)

Developments in Rolling Mill Construction (Neuerungen im Walzwerksbau) H. Kalpers. *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 24, Jan. 28, 1934, pages 38-40; Feb. 4, 1934, pages 57-58; Feb. 11, 1934, pages 70-71. Describes and shows new constructions of (1) blooming mills with special reference to a 2-high reversible blooming mill of Cockerill, distinguished by fully automatic operation and 3-high blooming mills of Maschinenfabrik Sack, Düsseldorf-Rath, (2) cold rolling mills, a 6-roll cold rolling mill of Maschinenfabrik Schmitz, Düsseldorf, 4-roll cold rolling mill of Krupp-Gruson Works, Magdeburg for cold rolling automobile sheets up to 1450 mm. width, multiple-roll cold rolling mill of Ehrhardt & Sehmer, Saarbrücken, (3) cooling beds with special reference to new roller cooling beds, system Schloemann, (4) electrical machinery and auxiliary devices as new types of electromotors for blooming mills by Siemens-Schuckert and Allgemeine Elektrizitätsgesellschaft, Berlin, electromotors for roller beds, etc. GN (4a)

Machine Renders Sheets Free from Stretcher Strains. John D. Knox. *Steel*, Vol. 92, Apr. 24, 1933, pages 26-27. Steel sheets are usually passed through roller leveling machines just prior to stamping to eliminate stretcher strains. The Guibert and Kelley methods have been developed in the past few years and have found wide use, and the desirable features of the 2 methods have now been incorporated in the Budd-McKay sheet processing machine. In this machine, the flexing of the sheet is carried further beyond the elastic limit than has heretofore been possible in roller leveling practice. MS (4a)

The "White-Strip" Mill (Das Weissbandwerk) W. Kraemer. *Zeitschrift Verein deutscher Ingenieure*, Vol. 77, Dec. 23, 1933, pages 1359-1361. White-strip is the name given to a tinned, cold-rolled strip-iron which was first produced under war emergencies, first as tin plate, later as not-tinned plate. It is used for cans in the canning and preserving industries and usually made in widths from 50 to 320 mm. It is produced in a continuous mill from slabs. A mill for production of 30-35 tons in 8 hrs. is described in detail. Ha (4a)

Roll-neck Lubrication. Walter D. Hodgson. *Sheet Metal Industries*, Vol. 7, Sept. 1933, page 274. A short discussion recommending the use of oil lubrication. AWM (4a)

Principles of Pilger Mill Roll Design. P. T. Emeljanenko. *Domez*, No. 10, 1933, pages 35-48. In Russian. Detailed mathematical treatment of the dimensions of rolls required for different methods of pipe rolling. Constant reduction, constant displacement, constant and changeable rate of rolling methods are investigated. (4a)

Roll Drafts Are Controlled by New Screwdown Device. *Steel*, Vol. 93, Dec. 4, 1933, pages 26, 28. See *Metals & Alloys*, Vol. 4, Dec. 1933, page MA 404. MS (4a)

Remodeled Sheet Mill in India Meets Expectations of Increased Output. *Steel*, Vol. 92, May 8, 1933, page 28. Brief description of mill of the Tata Iron & Steel Co., Ltd., Jamshedpur, with results obtained. MS (4a)

Perfects New Type Cold Mill to Simplify Sheet Planishing. *Steel*, Vol. 93, July 31, 1933, pages 28-29. Mill developed by E. W. Bliss Co. for planishing wide sheets ranging from 48 to 72 in. has 2 short rolls having vertical adjustment, 1 bearing against the upper planishing roll and the other against the lower. Instead of putting crowns on the rolls as heretofore, or changing their shape by use of gas flames, all that is necessary is to adjust these short contour rolls as required by the width of the sheets and the amount of work to be performed. MS (4a)

Roller Bearings for New Cold Mill Specially Designed. *Steel*, Vol. 93, July 10, 1933, page 26. Bearings for the backing-up rolls of the 84-inch 4-high mill of the American Sheet & Tin Plate Co., Gary, Ind., are 51 in. outside diameter and have a capacity of 3000 tons at mill speed. They are of the 2-row taper type and are made of high-C high-Cr electric steel, hardened by a "differential hardening" process. MS (4a)

Cold Working (4c)

Corrosion-Resisting Steel Sinks Formed in One Operation. *Steel*, Vol. 92, Jan. 30, 1933, page 26. Joseph Heinrichs Corp., Long Island City, produces seamless, non-welded sinks fabricated of one 18-8 sheet. Unit is heated for 2-3 min. at 1950° F. and then cooled rapidly. Heavier gages are H_2O quenched, lighter sheets are generally air cooled. Weight of average bowl unit is 15 lb. MS (4c)

Brake-Drum Surfaces Made Smooth and Extremely Hard by Planishing. *Machinery*, New York, Vol. 39, July 1933, page 716. Describes and illustrates the process and machine used. The machine is a product of the National Automatic Tool Co. RHP (4c)

Making Propeller Shafts. *Automobile Engineer*, Vol. 23, Apr. 1933, pages 119-123. Illustrates and describes methods of the Hardy-Spicer and Co., Ltd. Considers heat treatment, grinding, drilling, machining, welding, testing, and design. RHP (4c)

Ford Draws Own Wire at Rouge Plant. *Iron Age*, Vol. 131, Jan. 26, 1933, pages 166-167. Describes method and equipment used at the Rouge plant of the Ford Motor Co., Detroit, Mich. VSP (4c)

Bandsaws and Aluminium Foundries. *Metal Industry*, London, Vol. 44, Feb. 2, 1934, pages 137-138. Best type of saw for cutting of Al (as for instance of runners, risers, etc. of castings) in the cleaning department of a foundry is considered to be one made of self-or air-hardening steel about 1/32" thick. General points on shape of teeth, speed of cutting and care of saws are discussed without giving definite figures. Ha (4c)

Sheet Metal Working. *Automobile Engineer*, Vol. 23, July 1933, page 248. Description and illustrations of a roller leveling machine and of a press both used for automotive work. RHP (4c)

Some Practical Aspects of Modern Machine Hack-sawing. J. Trickett. *Mechanical World & Engineering Record*, Vol. 95, Feb. 16, 1934, pages 141-142. The author analyses the properties and requirements of machines, blades, and work, and shows how the three can be combined most economically. Recommendations are given as to the methods of testing and selecting blades. Kz (4c)

Testing the Drawing Properties of Rolled Zinc Alloys. E. H. Kelton & Gerald Edmunds. *American Institute Mining & Metallurgical Engineers, Technical Publication* No. 545, Feb. 1934, 8 pages. Neither the familiar mechanical tests nor the "dynamic ductility" test indicate the drawing properties of Zn and Zn-alloy sheet. A double-acting press was used for determining drawing ability. Cutting punches of several diameters were used with the same drawing punch and die and the drawability determined by the take-in (the difference between blank diameter and cup diameter divided by blank diameter) that could be used in obtaining unbroken shells. The greatest drawability is found in sheet cold-rolled to intermediate reductions in thickness. JLG (4c)

Relation between Plastic Deformation in Deep Drawing and Tensile Properties of various Metals. M. H. Sommer. *Metals Technology, American Institute Mining & Metallurgical Engineers, Technical Publication* No. 541, Feb. 1934, 19 pages. The stresses in a disc being drawn into a shell are analyzed. There are 3 distinct forces: (1) the composite stress that compresses the portion of the flange that must be dislodged when the diameter of the blank is reduced, (2) the friction on both sides of the die, and (3) the stresses resulting from bending the material around the edge of the die. Stress 1 is by far the largest and for a first approximation of the effective stresses the others may be neglected. The mathematical determination of the stresses is illustrated and the relationship between behavior in drawing and tensile values is discussed. Stress-strain curves for annealed ferrous and non-ferrous materials were determined. Actual stress was plotted against elongation where elongation after necking began was calculated from measurement of reduction of area. It is shown that values of actual stress for corresponding values of elongation divided by tensile strength give values that are indicative of the drawing ability of the material, the drawing quality being inversely proportional to the unit stress divided by the tensile strength. Curves shown prove that the tensile values so interpreted really do indicate drawing quality. The curves also lead to valuable conclusions regarding behavior at subsequent drawing operations. JLG (4c)

The Development of Internal Stresses and Season-Cracking in Cold-Drawn Brass Tubes. James Fox. *Engineering*, Vol. 136, Oct. 6, 1933, pages 375-376. Tests were made to determine the best combinations of sink and reduction in the thickness which may be given to cold-drawn brass tubes to produce internal stresses below the values necessary for season-cracking to occur. Mercurous nitrate was found to be the best thing to use to detect the presence of season-cracking in cold-drawn brass tubes. Ammonia is the best for the mandrel-drawn tubes. For manufacturing 2-in. diameter tubes free from the liability to season-crack the following rules were worked out: (1) Reductions in thickness between 5% and 50% may be accompanied by a maximum reduction in diameter of ⅛ in. (2) Reductions in thickness between 10% and 50% may be accompanied by a maximum reduction in diameter of ¼ in. (3) Reductions in thickness between 30% and 50% may be accompanied by a maximum reduction in diameter of ½ in. (4) Reductions in thickness between 40% and 50% may be accompanied by a maximum reduction in diameter of ¾ in. In hollow-sunk tubes, especially in the smaller diameter, the liability to season-cracking is much more pronounced than in the mandrel-drawn tubes. Internal stresses increase rapidly with sink and diminish rapidly with increase in reduction in thickness. Tables are given showing the exact results of these tests. LFM (4c)

Emission of Gases by Worked Metals (Ueber die Gasabgabe bearbeiteter Metalle) O. Werner. *Zeitschrift für Elektrochemie*, Vol. 39, July 1933, pages 611-616. The effect of drawing, rolling, or other working of metallic surfaces on the escape of included gases was studied by incorporating in the metal a radium alloy, usually Ra-Ba-Zn, and studying the escape of Ra emanation. The density of the alloy is changed by the deformation, the emanation given off can hereby increase to 5 times the original amount. Recrystallization goes on in 2 stages with entirely different velocity. The temperature of the maximum velocity of recovery as a function of the degree of deformation was studied; a maximum of emission of emanation was observed at the temperature of spontaneous recovery. This agrees with observations of Tammann. Ha (4c)

Machining (4d)

H. W. GRAHAM, SECTION EDITOR

Russian Tests on Cutting Materials. I. A. Swidlo. *American Machinist,* Vol. 78, Jan. 3, 1934, pages 10-13. A comparison of cutting qualities of high-speed steel and stellite carried out in an exhaustive test in Soviet Russia is described in detail. The coefficient of efficiency of stellite in removing metal in relation to the high speed steel tool was found to be 1.78, time saved in machining using stellite tool reached as high as 78%. Removing one ton of Ni steel requires 8.7 to 8.6 times as much high speed as stellite; even with a price of stellite tools 3½ times as great as of high-speed tools stellite would be justly preferred. The welding of the stellite tip to the steel shank is dependable and economical. The most practical set-up angle for the stellite tool is 70°-80° with a cutting angle of 80°. The quality of the sample tool was not changed after 10 times sharpening. Ha (4d)

Cutting Forces in Threading (Die Schnittkräfte beim Gewindebohren) H. J. Schroeder. *Zeitschrift Verein deutscher Ingenieure,* Vol. 78, Jan. 13, 1934, pages 60-61. From tests and theoretical considerations the required force and energy was charted for threading of nuts and holes. Shape and lengths of threader with regard to length of thread have considerable influence. Ha (4d)

The Vauxhall Works. *Automobile Engineer,* Vol. 23, Sept. 1933, pages 319-325. Describes and illustrates the plant and equipment used for making these cars. Tools included are lathes, boring and drilling machines, and lapping machines. RHP (4d)

Improved Lathes. *Automobile Engineer,* Vol. 23, May 1933, pages 177-179. Describes and illustrates machines developed by several British companies. All are designed especially to use cemented carbide cutting tools. RHP (4d)

Front-Axle Manufacture. *Automobile Engineer,* Vol. 23, Dec. 1933, pages 497-502. Describes and illustrates the machining processes and tools used by Alford and Alder, Ltd. Processes are given in detail but does not mention the metal used. RHP (4d)

Piston Manufacture. *Automobile Engineer,* Vol. 23, Nov. 1933, pages 411-415. The Automotive Engineering Co., Ltd. produces a B. H. B. self-adjusting piston of Rolls-Royce Hiduminium R. R. 53 die-cast alloy. Describes and illustrates tools and instruments and gives details of machining methods. RHP (4d)

Researches on the Cutting Action of Planing Tool by Microkinematographic, Photoelastic and Piezoelectric Methods. Makato Okoshi & Shinji Fukui. *Scientific Papers Institute of Physical & Chemical Research, Tokyo,* Vol. 22, Oct. 1933, pages 97-166. In English. The experimenters succeeded in taking films of 2-dimensional cutting action of a planing tool (20 W, 3.5 Cr, 0.6 V, 5 Co, 1 Mn, .8 C) on cast Fe, mild steel, brass and copper. The induced displacements were made visible by square lines on the face sides of the work. A flow slip and crack type of chip was observed. At a 60° cutting angle the material below the surface was pulled upwards and some parts next to be cut pushed downwards. At 90° the material near the cut surface was displaced horizontally in the direction of cut. The amount of displacement changed in both cases with the depth of contact. At 60° the vertical tensile strain is larger and at 90° the shearing strain is larger. Near the cutting edge, large vertical strain and horizontal shearing stress exists. Photoelastic experiments analogous to the actual cutting action are made and the results of both methods coincided fairly. Microkinematographic records of photoelastic phenomena occurring in celluloid machined by glass tools were taken. These revealed that the cutting force seems to act on the tool not at a point but with some sort of a distribution. The change of the cutting force is closely related to the mode of chip formation. As the tool cuts deeper the cutting force becomes larger corresponding to the change of induced strain. When slip or crack occurred the force dropped suddenly. In some cases a linear relation was observed between the displacement of the cutting edge in the direction opposite to cut and the magnitude of the cutting force. 80 illustrations. WH (4d)

Dynamic Chipping Phenomena and Their Effect on Formation of Surfaces (Dynamische Zerspanungsvorgänge und ihr Einfluss auf die Oberflächenbildung) W. Leyensetter. *Zeitschrift Verein deutscher Ingenieure,* Vol. 77, Dec. 30, 1933, pages 1376-1377. The formation of a surface by a chipping process depends on the behavior of the cutting edge under operation; the behavior changes with changing cutting velocities. The total consumed energy does not increase in same proportion with increase in cutting velocity which means that the relatively greater energy consumption at lower velocities brings about an unwanted destruction of the surface structure. Microphotographs show the influence of cutting velocity and vibrations on surface structure. Ha (4d)

Effect of Cutting Pressure on Machineability (Schnittdruck, Schnittdruckschwingungen und Werkstoffverformung) W. Leyensetter. *Stahl und Eisen,* Vol. 53, Nov. 16, 1933, pages 1184-1186. Cutting pressures and variations in pressure during turning low-carbon and Cr-Ni steel in a lathe were measured with an electrical dynamometer. At higher cutting speeds the cutting pressures were lower and more uniform and correspondingly the machined surfaces were smoother. SE (4d)

How Wood-Boring Bits are Made. A. E. Granville. *Modern Machine Shop,* Vol. 6, Feb. 1934, pages 7-10, 26. Describes factory processes from the round bar to the finished product. Ha (4d)

A Giant Universal Machine. *English Mechanics,* Vol. 14, July 14, 1933, pages 241-242. A unique robot machine, electrically operated, that can drill, bore, tap and mill large parts, recently completed at the works of W. Asquitt, Ltd., Halifax. The vertical traverse of the slide is 8 ft. 4 in. and the machine is arranged to give 27 spindle speeds ranging from 1-100 r.p.m. It has 9 milling feeds, namely from 24-300 r.p.m. The main spindle is driven by a 30 HP motor. Unique features are such as concentrated controls and interlocking. WH (4d)

Giant Combined Milling and Planing Machine (Schweres kombiniertes Fräs- und Hobelwerk) Weil. *Werft, Reederei und Hafen,* Vol. 14, June 1, 1933, pages 148-150. Detailed description of a machine recently built by the German Schiess-Defries A.G., Düsseldorf, which incorporates 15 motors, permits planing and milling operations on a 10,000 mm. length, 4,200 mm. width and 5,000 mm. height. Table is designed for a maximum load of 100 tons. Total weight of machine amounts to 350 tons. Facilities are provided to drill holes and mill in the direction of the table as well as perpendicular to it but to plane only in the direction of the table. WH (4d)

Choosing a Cutting Material. R. R. Weddell. *American Machinist,* Vol. 77, May 10, 1933, pages 300-301. A chart showing the relationship between red-hardness and toughness of several cutting steels. With increasing red-hardness toughness decreases. Cemented carbide is so far the hardest cutting material known. General viewpoints in choosing a material are discussed. Ha (4d)

Development of German Machine Tools During the Last Four Years (Die Entwicklung des deutschen Werkzeugmaschinenbaues in den letzten vier Jahren) A. Wallichs. *Zeitschrift Verein deutscher Ingenieure,* Vol. 77, Oct. 7, 1933, pages 1081-1086. Trends and constructive details, special machines and manual tools are reviewed and illustrated. 23 references. Ha (4d)

Judging the Chippability of Metals (Die Beurteilung der Zerspannbarkeit von Metallen) H. Schallbroch. *Zeitschrift Verein deutscher Ingenieure,* Vol. 77, Sept. 9, 1933, pages 965-971. The factors on which the chippability of a material depends are discussed at length in order to derive a value which can serve as a guide to the shop engineer to determine time, power and tools required for the working of material. Different values are found for turning, drilling, milling and grinding, and relations with the hardness of the material investigated. Shape of tool, speed of carrying off the chips, chemical composition are of importance. A higher S content favors chipping. 49 references. Ha (4d)

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HEAT TREATMENT (5)

O. E. HARDER, SECTION EDITOR

Heat Treatment of Gold Alloys to Avoid Brittleness upon Hardening (Die Warmbehandlung von Goldlegierungen zur Vermeidung des Sprödwerdens bei der Verfestigung) *Deutsche Goldschmiedezeitung*, Vol. 37, Jan. 13, 1934, page 31. A large number of gold alloys requires a certain heat treatment to make them fit for further working. However, upon applying these methods, brittleness frequently results, thus rendering further working difficult. Author found that 2nd heating required for hardening is extended too long in former methods, a short cycle heating brings about desired increase of hardness without brittleness. An alloy of 76% Au, 24% Ag was heated to 850°C. for 50 min., then quenched. Hardness amounted to 152 Brinell. In this state alloy could be worked well and showed no brittleness. After finish working alloy was heated at 450°-480°C. for 1 hr., hardness increased to 198 Brinell. An alloy of 90% Au, 10% Ni showed after heating to 850°C. and subsequent quenching a hardness of 174 Brinell and was not brittle, thus offering no difficulties in working. After finish working alloy was heated at 450°-480°C. for 1 hr. and hardness increased to 198 Brinell. GN (5)

Hot-Heading and Heat-Treating of Bolts. J. B. NEALEY. *Fuels & Furnaces*, Vol. 12, Jan.-Feb. 1934, pages 22-25. Layout of plant and equipment, furnaces, and manufacturing methods of the Oliver Iron and Steel Corp., Pittsburgh, Pa., are described. Ha (5)

Temperature Distribution and Heat Treatment of a Heated Plate (Temperaturfeld und Wärmebehandlung einer beheizten Platte) E. HELWEG. *Archiv für das Eisenhüttenwesen*, Vol. 7, Nov. 1933, pages 293-300. Formulae are derived, the use of which are illustrated by sample calculations, for determining the temperature distribution in various plate sections on heating and cooling. The manner of calculating the effect of this on the internal stress distribution and on the grain size at the surface and interior of the plate is also illustrated by numerous simple examples, checked by actual tests. SE (5)

Annealing (5a)

Dry, Bright Annealing of Copper Wire. A. R. RYAN. *Wire & Wire Products*, Vol. 9, Mar. 1934, pages 75-80, 92. Wire on reels is annealed in a bell-type furnace with gas circulation at 390°C. to obtain the proper microstructure in the Cu wire. Charts giving tensile strength, elongation and conductivity as function of cold-working and annealing temperature are given. Ha (5a)

Cold-Rolled Strip Bright Annealed in Controlled Gas Atmosphere. L. E. BROWN. *Steel*, Vol. 93, Oct. 30, 1933, pages 25-27. Thompson Wire Co., Boston, has installed 3 electric, bell-type, controlled atmosphere furnaces for bright annealing. Charge is built up in 3 sections on a car-type semirefractory base through which the atmosphere is introduced and is covered by a cylindrical, heat-resisting steel hood. Extending completely around the base is an oil compartment which seals the flange of the hood. Charge, which averages 7500 lbs., is then placed in furnace proper. Atmosphere is either purified city gas or dissociated NH_3. Heating period is 6-14 hrs. for low-C steels, while for high-C steel, 6-10 hrs. additional is necessary for spheroidization. Cooling period before lifting the hood is 30-50 hrs. Temperature variation throughout the charge during annealing is held to ±10°F. MS (5a)

Annealing Low Carbon Steel Wire. THEO. B. BECHTEL. *Wire & Wire Products*, Vol. 9, Feb. 1934, pages 39-40, 58. The insufficiency of batch-annealing low-C steel wire is pointed out and a new method developed by which the pot with the wire is removed from the furnace while at maximum temperature; this required changes in the pot construction and firing arrangement. Cooling and heating cycle were in this way shortened and quality of the wire was improved due to greater temperature uniformity. Ha (5a)

Hardening, Quenching & Drawing (5b)

Manufacture and Heat Treating of Twist Drills. J. B. Nealey. *Iron Age*, Vol. 131, Mar. 30, 1933, pages 508-509, adv. sec. page 8. Describes method used by the American Twist Drill Co. Most of the drills made are of the following analysis: C 0.86-0.73%, W 18.00%, Cr 4.00%, V 1.00%, Mn 0.25%, Si 0.20% and S and P 0.015 % each. Shank stock of two analyses: (1) C 0.40-0.50%, Mn 0.50-0.80%, P 0.045% and S 0.05% maximum, and (2) C 0.15-0.25%, Mn 0.30-0.60%, Cr 0.45-0.75%, Ni 1.00-1.50%, S 0.045% and P 0.04% maximum. Normalizing is done at 1700-1750° F. and stock is allowed to cool in furnace. Forge furnaces are of slot type and are fired with gas. Drills after being unpacked from the pipes, are reheated for twisting at temperature of about 2150° F. Final heat treatment produces a martensitic grain structure and is accomplished by first preheating in a Pb bath to 1600° F. and then bringing up to 2350° F. in a high-heat furnace. Quenching in oil leaves it in austenite form and this is changed by reheating to 1060° F. for small and 1100° F. for large drills and soaking at this heat from 1½ to 2½ hrs. Modern equipment is used. VSP (5b)

Influence of Quenching Conditions on the Internal Stresses of Steels (Einfluss der Abschreckbedingungen auf die Eigenspannungen von Stählen) H. Bühler & E. Scheil. *Archiv für das Eisenhüttenwesen,* Vol. 7, Dec. 1933, pages 359-363. Another of the series of studies by the authors of the internal stresses arising in quenching steel. In steels containing 9 to 23% Ni, lowering the temperature of the quenching bath to the temperature range of martensite formation, caused the influence of this transformation on the formation of internal stresses to increase. Raising the quenching bath temperature above this range therefore tended to reduce the internal stresses from this cause and likewise those arising from temperature gradients. In hardening medium plain carbon steel the temperature of the bath should be in the range of martensite formation to reduce internal stresses, or preferably a little higher, but at the same time the critical cooling rate through Ar′ must be exceeded if complete hardening is to be effected. SE (5b)

Internal Stresses in Heat Treated Hollow Steel Cylinders (Eigenspannungen in wärmebehandelten Hohlzylindern aus Stahl) H. Buchholtz & H. Bühler. *Archiv für das Eisenhüttenwesen,* Vol. 7, Nov. 1933, pages 315-317. Various sizes longitudinal holes were drilled in cylinders of 0.3% C steel 50 to 230 mm. in diameter, and the effect of these holes on the hardness and internal stresses after quenching, were determined. The temperature gradients during quenching were lower in hollow than in solid cylinders, and the internal stresses were, therefore, also lower, despite the higher cooling rates in the bored out cylinders. The hollow cylinders tended to harden more deeply. In the quenched hollow cylinders compression stresses were found to exist at the inner and outer surfaces, and tensional stresses in the interior of the wall. SE (5b)

Coal Cutter Picks and Their Treatment. *Edgar Allen News,* Vol. 12, Feb. 1934, pages 384-385. A special "Stagpick" steel (to be described in a future issue) is used and must be die-forged and subject to a definite, described heat-treatment and oil-hardened. Periodical normalizing of the tools is recommended to restore the steel to its normal condition and to remove strains set up in operation. Heating to about 850° C. and quenching in oil (not water) should be applied. Ha (5b)

Production of Bolts, Nuts, Screws and Rivets. J. B. Nealey. *Wire & Wire Products,* Vol. 9, Mar. 1934, pages 81-83, 91. Production methods, heat treatment, gas and fuel-heated furnaces, and cleaning methods are described. Ha (5b)

Effect of Quenching Temperature on the Hardening of Steel (Einfluss der Abschrecktemperatur auf die Stahlhärtungsvorgänge) H. Esser & H. Majert. *Archiv für das Eisenhüttenwesen,* Vol. 7, Nov. 1933, pages 319-322. By means of a thermomagnetic apparatus for determining the critical points during very rapid cooling, it was found that the magnetic transformation in iron could be retarded somewhat by quenching, a reduction of about 5% in the magnetic saturation of electrolytic iron being obtained. The pearlitic transformation in steel was more easily suppressed when higher quenching temperatures were used, even with constant rates of cooling through the critical region. It was suggested that at higher heating temperatures nuclei which might otherwise induce the pearlite transformation are dissolved in the austenite. SE (5b)

Influence of Various Alloying Elements on the Hardenability of Steel (Der Einfluss verschiedener Legierungselemente auf die Abschreckhärtbarkeit von Stahl) H. Esser, W. Eilender & H. Majert. *Archiv für das Eisenhüttenwesen,* Vol. 7, Dec. 1933, pages 367-370. The critical cooling velocity at which troostite instead of martensite first begins to appear on quenching was determined for 0.3 to 1.5% C steels alloyed with various elements. Additions of Mn and Ni progressively lowered the critical cooling velocity. Small amounts of Cr, Si, and W lowered the critical cooling velocity but larger amounts raised it. For high quenching temperatures (1100°C) V behaved similarly, but for lower quenching temperatures (950-1000°C) V progressively raised the critical cooling velocity. Co progressively lowered it. SE (5b)

Electrical Equipment of Leaf Spring Bending and Hardening Machines (Elektrische Ausrüstung von Blattfederbiege- und Härtemaschinen) Karl Haller. *Brown Boveri Nachrichten,* Vol. 20, Oct.-Dec. 1933, pages 135-138. For both manufacturing as well as repairing of leaf springs the described bending and hardening machine offers the essential advantages of maintaining accurately the desired curvature of the spring, uniform quality and hardness. The main part of the machine is the leaf grip pattern into which the spring set is inserted in hot state and bent to shape. After bending, this pattern together with the bent leaf spring is submersed in water for hardening. For avoiding formation of vapor bubbles and subsequently setting up of stresses in leaf spring water is stirred by blowing air into hardening vessel. Water temperature is kept constant by a thermostat. GN (5b)

Aging (5c)

The So-called Incubation in the Hardening of Duralumin (Über die sogennante Inkubationszeit bei der Duraluminaushärtung) W. Fraenkel & R. Hahn. *Zeitschrift für Metallkunde,* Vol. 25, Aug. 1933, pages 185-189. Tensile tests and measurements of electrical conductivity and Brinell hardness were performed on a series of alloys of the duralumin type during aging at room temperature. It was found that the incubation period, i.e., that period at the beginning of aging during which little or no change occurs, is dependent chiefly upon grain size, increasing in degree as the grain size increases. Very pure materials are in general less inclined to incubation than commercial materials; impurity of Fe seems to favor the occurrence of an incubation period. Followed by a discussion in which other data on incubation are given. RFM (5c)

Repeated Hardening of Duralumin Rivets and the Influences of the Hardening Temperature (Versuche über die wiederholte Aushärtung von Duralumin-Nieten und über den Einfluss der Aushärtungs-Temperatur) Martin Abraham. *Zeitschrift für Metallkunde,* Vol. 25, Sept. 1933, pages 203-206. The claim that the interruption of the hardening process with immediate rehardening leads to more rapid hardening is shown to be unimportant, the effect small and of no practical significance. The course of hardening with repeated hardening remains the same if the rivets are not treated for five days between the solution heat treatments. The influence of temperature of aging upon the rapidity of aging is much greater: a temperature difference of 20° can produce a difference of 4 kg./mm.² shearing strength after a two-hour aging. The limit of working for rivets of duralumin wire of the German specification 681 ZB is around 25 kg./mm.² shearing strength. This strength is reached on a ten-hour aging at 8°. The data are given largely in the form of graphs, drawn from tests on duralumin alloys 681 A and 681 ZB. RFM (5c)

FURNACES, REFRACTORIES & FUELS (6)

M. H. MAWHINNEY, SECTION EDITOR

Heat Losses in Furnace Operations. S. N. Brayshaw. *Iron & Coal Trades Review,* Vol. 126, Mar. 24, 1933, pages 464-465. See *Metals & Alloys,*
Vol. 4, Nov. 1933, page MA 367. Ha (6) 1

Forced Air Circulation Furnaces. *Metal Industry,* London, Vol. 42, June 16, 1933, pages 617-618. Arrangement of fans for circulating the air in batch-type furnaces for low temperature heat treatment is described. Ha (6)

Service Results on Industrial Electric Furnaces (Betriebsergebnisse Industrieller Elektroöfen) *Elektrizitätswirtschaft,* Vol. 32, Aug. 15, 1933, page 320. The following data were gained on furnaces installed in industry:

Kind of Furnace	Input kw.	Daily output in tons	Energy consumption in kwh./ton	Energy consumption in 10^6 kwh./yr.	
(a) Induction furnace, 1000 kg. capacity for high-grade castings	100	30-40	50-70	0.63	
(b) Aluminum melting furnace	220	15	400	1.8	
(c) melting furnace for Cu and Cu alloys	120	12	170-200	0.61-0.72	2
(d) strip annealing furnace	60	12	92	0.31	

In (a) Fe from 2 cupolas is introduced at 1250° C., heated to 1600° C. in the induction furnace and the alloy elements are added. In (b) 7 furnaces of 2 tons each are in service. In (d) furnace temperature of 590°-620° C. for strips of 700 mm. width and 3 mm. thickness max. An electrically heated tube annealing furnace and crucible furnace are illustrated and service data given. EF (6)

Refractories. R. P. Heuer. *Transactions American Institute Mining & Metallurgical Engineers, Copper Metallurgy,* Vol. 106, 1933, pages 278-281. Brief discussion of refractories suitable for Cu-smelting furnaces. Points out advantages of unburned magnesite brick. JLG (6)

Some Experiments on Frothed Clays. S. R. Hind. *Transactions Institution* 3
of Gas Engineers, Vol. 79, 1929-30, page 228. China clay and ball clay slips were treated to give a froth (method not given), the froth dried, fired to 1250°, ground for grog, bonded with 15% ball clay and refired to 1200°. The thermal conductivity at 267°-500° was 0.00050, at 415°-800°, 0.00064 and at 640°-1100°, 0.00077. AHE (6)

Calculation of the Heating Surface of a Counter Current Heat Regenerator (Die Berechnung der Heizfläche eines Gegenstrom-Wärmeaustauschers) K. Rummel, H. H. Böhm & G. Schefels. *Archiv für das Eisenhüttenwesen,* Vol. 7, Nov. 1933, pages 301-304. Approximate calculations for determining the rate of temperature change of the heating surface of a regenerator stove and the temper-
ature of the heated gas and air are illustrated. Examples are taken from data on 4
blast furnace regenerators. SE (6)

A Note on the Surface Flaking of Vertical Retorts. A. J. Dale & V. Hackney. *Transactions Institution of Gas Engineers,* Vol. 79, 1929-1930, pages 237-238, 245-253. Surface flaking is caused by surface strain developed during the incandescent combusion of the scurf. This strain is the result of the conversional expansion of the brickwork at the high surface temperature produced by combustion of the scurf, coupled with the contractile tendency of the adhering scurf at these high temperatures. AHE (6)

Some Effects of Temperature on Commercial Heat-Insulating Bricks. A. J. Dale & F. Wheeler. *Transactions Institution Gas Engineers,* Vol. 79, 1929-30, pages 224-228, 245-253. Data are given on porosity, cold crushing strength,
behavior under low load at high temperature, behavior when held under low load 5
just at or above temperature at which subsidence begins, and linear shrinkage after repeated heatings at 900° and 1000° for various kinds of bricks of diatomaceous earth. AHE (6)

On the Application of Oxygen in the Russian Industry (Über die Anwendung des Sauerstoffs in der Sowjet-Industrie) E. Pallas. *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 23, Dec. 17, 1933, page 701. An outline of the possibility of applying oxygen in the Russian steel industry is given, referring to its use in melting in open hearth furnaces, coke ovens (saving of checkers) gas producers, roasting of ores and similar instances are cited where the heat efficiency of metallurgical processes can be improved considerably. GN (6)

New Refractory for Open Hearth and Electric Steel Furnaces (Ein neuer feuerfester Baustoff für Siemens- Martin- und Elektrostahlöfen) E. Reitler. *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 24, Jan. 14, 1934, page 14. Author reports about a Spanish made new silica brick (agate brick) that is by far superior to best types of silica bricks known. This brick has been used in Spain most successfully for lining open hearth and electric steel furnaces. Raw material of these bricks is a mineral similar to agate composed almost of pure SiO_2 with small additions of Fe_2O_3. Comparative tests on silica and agate bricks prove superiority of latter. Seger cone fusion point is about 1 point higher, softening point under pressure 1720°-1750°C. against about 1630°C. for silica brick, sp. gr. about 2.33 against 2.41. Arches of electric furnaces lined with agate brick stood up 150 melts, those of hot worked open hearth furnaces 600 melts. In spite of high price use of agate bricks for mentioned purpose is economic. GN (6)

Explosion of Cupola Furnaces, Causes and Prevention (Kupolofenexplosion, ihre Ursachen und ihre Verhütung) J. Petin. *Die Giesserei*, Vol. 21, Jan. 5, 1934, pages 3-5. Dangers in operation of cupola furnaces can have their cause in collection of gases, mostly CO, after periods of rest which again give an explosive mixture with the air when the blast is started; the sudden increase of volume can do heavy damage. Also collection of water under the furnace can cause grave dangers if the furnace is emptied whereby dissociation of CO_2 and H_2O vapor takes place so that also here explosion-like conditions occur. A number of precautions which should always be carefully observed are given. Ha (6)

Furnace Construction to Reduce Slag Attack on Refractories F. H. Norton. *Fuels & Furnaces*, Vol. 12, Jan.-Feb. 1934, pages 11-17. Effects of slag on refractory materials and means to counteract them are discussed. The slag action takes place in the liquid form of the slag when it reacts with the constituents of the refractory, usually by dissolving it. Under certain conditions reaction can occur also between a solid flux and the refractory when at a particular temperature a liquid phase is formed, and also between gases and refractories, in particular between CO and firebrick where C may be deposited in the pores of the refractory around the Fe spots and finally cause rupture of the brick. Also mechanical action can be exerted by slag due to its motion. The composition of slags is given in a table. Means to defeat injurious action are the use of bricks of small porosity, reduction of joints to the least possible number as these often break out and form a capillary space into which the slag is drawn, or to use a rammed or poured monolithic construction. Cooling the refractory under very severe conditions has proved to be quite successful. Frequent replacement is often resorted to to prevent the effects of slag corrosion. Ha (6)

Modernizing the Plant with Electric Heating Equipment. A. N. Otis. *Steel*, Vol. 92, June 12, 1933, pages 23-26. Describes various types of electric heat treating furnaces and other heating equipment. MS (6)

Standardization of Heating Elements and Autotransformers (Normalisierung von Heizstäben und Spartransformatoren) K. Mertens. *Elektrowärme*, Vol. 4, Jan. 1934, pages 8-9. The considerable change in resistance by aging of silite and globar heating elements can be economically counteracted by providing autotransformers with definite steps which are selected for a series of standardized elements. A series of elements of silite and globar and transformers for operating them is developed. Ha (6)

Practical Experiences with K.-S.- Ellipsoid Rotating Furnace in Melting Iron (Betriebserfahrungen mit dem K.-S.- Ellipsoidofen beim Schmelzen von Eisen) Gustav Krebs. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, Jan. 21, 1934, pages 31-32. In commenting on Höhne's previous paper (*Zeitschrift für die gesamte Giessereipraxis*, Vol. 54, Oct. 15, 1933, pages 431-432 and subsequent issues) discussing use of mentioned furnace for melting non-ferrous metals, author outlines his experiences in melting cast Fe. A few more advantages of new furnace are enumerated as uniform and slow abuse of furnace lining, low heat loss on account of radiation, favorable fuel utilization since gas inlet and outlet are on same side of furnace. Data on heat efficiency are given in melting cast Fe. The still rather high fuel consumption of 17%/t of molten Fe should be possible to be decreased by better operation method. Higher fuel costs in comparison with cupola are compensated by possibility of using cheaper raw material in charge and yet processing high test cast Fe. Ellipsoid furnace gives great reliability in melting, cast Fe of any desired analysis can be processed. GN (6)

Special Melting Equipment for Foundries (Sonderschmelzanlagen für Giessereien) H. Kalpers. *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 23, Dec. 3, 1933, pages 672-673. A number of new types of melting furnaces are described: (1) shaft furnace in combination with fore hearth according to Emmel-Jehnigen, distinguished by favorable heat utilization, possibility of attaining high temperatures, up to 1800°-2000°C., low absorption of S by melt, low loss of metal by oxidation, (2) rotating furnace by Klöckner Works, characterized by a unique arrangement of charging and discharging spouts making possible addition of liquid metal at any time, attaining good mixing of melt and facilitating slagging of melt, furnace can be used as melting furnace as well as mixer, (3) tilting reverberatory furnace by K. Schmidt, Neckarsulm, showing 2 shafts arranged side by side so that good utilization of heat is guaranteed and oxidation loss of metal is low, (4) gas fired melting furnace, system Humboldt-Deutz Motoren Co., in which the melting metal is not directly subjected to heating flames in that some sort of a screen (made of heat resisting alloy with a superficial layer of a highly heat conducting material as SiC) is arranged between combustion chamber and hearth, (5) shaft furnace, system Gewerkschaft Eisenhütte Westfalia, Lunen, in which the heating flames of a laterally arranged combustion chamber pass through the furnace shaft in horizontal direction, part of the gases is used for preheating the furnace charge, part is used for preheating of combustion air, (6) melting equipment of Maschinenfabrik Esslingen, composed of a cupola working together with several reverberatory furnaces used for refining; according to a patented method reverberatory furnace to be charged is connected with cupola as a closed furnace system so that flames of reverberatory furnace pass through cupola and metal melted in cupola flows directly in reverberatory furnace without oxidation and heat loss; however reverberatory furnaces can be operated also as single units, (7) cupola forehearth according to Böhm, aiming at avoidance of pipe and blowhole formation by generating low pressure above melt. GN (6)

Determining the Transmission of Heat in Industrial Furnaces. M. H. Mawhinney. *Steel*, Vol. 92, Apr. 24, 1933, pages 23-25; May 8, 1933, pages 23-25. Describes results obtained from an investigation of the operation of a number of commercial furnaces to determine reliable experimental values of overall coefficient of heat transfer. Studied furnaces in which the charge was large with respect to the furnace. Results are presented in tables and curves. Presents an example of the use of the data for determining temperature heads. MS (6)

Furnaces for High Temperatures, Especially for Ceramic Purposes, Melting and Forging (Feigenofen für hohe Temperaturen, insbesondere für Keramische Zwecke, Schmelzen und Schmieden) H. Masukowitz. *Elektrowärme*, Vol. 4, Jan. 1934, pages 15-18. Constructive details and operating data of furnaces are given which are equipped with a new design of heating element as described in *Elektrowärme*, July 1933, page 218, O. Junker. This element is like a ribbon with a reinforcing rib in the middle and permits an almost continuous heating surface to be built in front of the walls and under the roof; the latter can even be supported by the elements. A brass-melting furnace for a 100 kg. crucible and 8-9 castings/8 hrs. consumed only 300 kwhrs./ton of brass in continuous operation. Ha (6)

Note on the Possibilities of the Electric Furnace in the Foundry. B. R. Byrne. *Journal Institution of Locomotive Engineers,* Vol. 23, Mar.-Apr. 1933, pages 227-269. Includes discussion. Descriptions of the principal types of arc and induction furnaces are given, followed by a brief account of the properties of high test cast irons and of the methods of producing these in the arc furnace from either cold pig and scrap or from cupola metal (duplexing). Tabulated data show that electric melting can often be cheaper than using a cupola or a pulverized fuel furnace. JCC (6)

Balanced Heat in Iron and Steel Works. W. J. Brooke. *Metallurgia,* Vol. 9, Feb. 1934, pages 109-110. Discusses efficient utilization of heat in steel plants, with especial reference to blast-furnace and coke-oven gas. JLG (6)

Electric Furnaces with Demountable and Interchangeable Parts (Fours éléctriques à éléments démontables et interchangeables) Maurice Billy & Félix Trombe. *Bulletins de la société chimique de France,* Vol. 53, June 1933, pages 536-541. Authors suggest a furnace construction in which the heating units are subdivided in such a manner as to provide for the possibility of replacing them in case of failure but without discontinuing the heat treatment. Various heating and insulating bodies are illustrated and a diagram shows the temperature distribution in a tube furnace (28 mm. long) at temperatures ranging from 400°-1200°C. EF (6)

Recent Developments in Electric Bright-Annealing Furnaces (Neuere Entwicklungen in elektrischen Blankglühofen) Tamele. *Elektrowärme,* Vol. 4, Jan. 1934, pages 3-8. Box-type and continuous furnaces with and without protective atmosphere for the material are described, constructive details are illustrated. Continuous furnaces have been built mainly for comparatively small section of material to be heated as the difficulty of a gas-tight closure of the heating chamber for the protective atmosphere is rather great. Bright annealing without protective atmosphere is done by preventing oxygen from coming into contact with the material while it cools down. Ha (6)

Carbon Arch for Electric Steel Furnaces (Kohlenstoff-Gewölbe für Elektrostahlöfen) Viktor Zsak. *Stahl und Eisen,* Vol. 53, Jan. 26, 1933, pages 92-93. Roofs made of a mixture of fine coke and pitch, tamped into a mold, gave very satisfactory service, 80 to 100 melts of about 1200 kg. The charge in these furnaces was acid. Ha (6)

Refractories and Sands for the Non-Ferrous Industries. A. B. Searle. *Metal Industry,* London, Vol. 44, Jan. 12, 1934, pages 67-69. Properties of materials used in refractory structures are discussed, the most important to consider are: refractoriness under load, after-contraction, porosity or water absorption and specific gravity. Particular points to be observed for Zn, Cu, brass, white metal residues, Ni and its alloys, Al and its alloys, Pb and Sb are described. Ha (6)

The Physical Properties of Heat-Insulating Material for Temperatures Above 500° C. (Die physikalischen Eigenschaften der Wärmeschutzstoffe für Temperaturen über 500° C.) J. S. Cammerer. *Elektrowärme,* Vol. 4, Feb. 1934, pages 41-45. Heat conductivity, permanence in elevated temperatures and compressive strength were investigated for some of the most used heat-insulations and compiled in the following table:

Material	Density kg./m.^{3}	Heat conductivity kgcal./m. hr. at		Permanence vertical to heat flow	Compress. strength
		100°C.	500°C.	up to °C.	kg./cm.^{2}
Silocel, super	610	0.195	0.245	1370	25
Silocel, C22	610	0.193	0.237	1100	38
Superdia	750	0.180	0.236	1350	16-20
Cristobalite	600	0.157	0.185	1160	12-15
Feuerleicht	900	0.195	0.260	1200	30
Diatomite F	700	0.170	0.230	1500	30-40

Ha (6)

Electrical Equipment for Induction Furnaces C. C. Levy. *Electrical Engineering,* Vol. 53, Jan. 1934, pages 43-48. Frequency converter and induction furnace for 300 KVA at 960 cycles with complete control is described. 10 references. Ha (6)

Practical Tests on Refractory Cements W. O. Lake. *Sands, Clays & Minerals,* Vol. 2, Feb. 1934, pages 35-39. Compositions of refractory cements suitable for the metallurgical industries are given. One of the best results was obtained with 58.02% SiO_2, 5.94 Al_2O_3, 1.6 Fe_2O_3, 0.31 TiO_2, 0.46 CaO, 0.03 MgO, 0.33 K_2O, 3.32 Na_2O, 26.39 H_2O, 3.45 MnO_2. Ha (6)

The Design and Operation of Industrial Gas Furnaces. E. A. Leask. *Gas World,* Vol. 98, June 17, 1933, pages 8-11. Paper read before the meeting of the Manchester District Gas Association. Describes a natural gas oven furnace and a reversible control furnace, and gives the advantages and disadvantages of natural draught versus low pressure aid. Also discusses central heating costs and how gas furnaces are better than electric ones. MAB (6)

The Part Gas Plays in the Wire Trade. J. Bradbury. *Gas World,* Vol. 98, Mar. 18, 1933, pages 8-10. See "Gas in the Wire Drawing Industry. Experience at Halifax," *Metals & Alloys,* Vol. 5, Mar. 1934, page MA 102. MAB(6)

Seamless Tubing for Cold Drawing Is Dried in Continuous Oven. H. M. Heyn. *Steel,* Vol. 93, Aug. 7, 1933, pages 25-27. Oven is used for drying tallow and flour on tubes from ½ to 10 in. in diameter and from 6 to 33 ft. in length. It is built beneath the floor level, the mill floor serving as the roof. Oven is 36 ft. wide and 50 ft. long. Tubes are charged and taken out of the pits by crane. Conveying mechanism consists of 7 continuous chains running through the oven in channel irons. Heating and recirculating equipment for supplying hot air to the furnace is installed on the mill floor. Air is forced down to the bottom of the oven and up around the tubes. Recirculating fan is rated at 40,000 ft.^{3}/min. at 4 in. H_2O static pressure. Oven is fired by 3 direct gas-fired push-through type heaters. MS (6)

Some Special Applications of Industrial Electric Heating (Einige Sonderanwendungen der industriellen Elektrowärme) G. Gobbers. *Elektrowärme,* Vol. 4, Mar. 1934, pages 56-58. Construction and heating elements of box-type, multiple and melting furnaces with built-in or suspended heating elements are described. Ha (6)

Heat Transmission, with Particular Reference to Modern Methods of Expressing Convection Data. Margaret Fishenden. *Transactions Institution Gas Engineers,* Vol. 79, 1929-30, pages 578-609. AHE (6)

Development in the Application of Solid Fuel to Non-Ferrous Furnaces. John Fallon. *Metal Industry,* London, Vol. 44, Jan. 12, 1934, pages 63-65. Improvements in design of furnaces for annealing and heat-treating, control arrangements are described and illustrated. Ha (6)

High-Frequency Furnace in Theory and Practice for the Field of High Temperature (Der Hochfrequenzofen in Theorie und Praxis für das Gebiet hoher Temperaturen) W. Esmarch. *Die Naturwissenschaften,* Vol. 21, Feb. 10, 1933, page 149. See *Metals & Alloys,* Vol. 5, Jan. 1934, page MA 27. EF (6)

The After-expansion and True Specific Gravity of Silica Refractories for Carbonizing Plant. A. J. Dale, H. T. S. Swallow & F. Wheeler. *Transactions Institution of Gas Engineers,* Vol. 79, 1929-30, pages 229-237, 245-253. (6)

The Construction and Application of Calrod Heating Units. R. M. Cherry & F. E. Finlayson. *General Electric Review,* Vol. 36, Aug. 1933, pages 354-360; Sept. 1933, pages 411-415. Development of heating units is reviewed. Construction of various types of heating equipment is outlined. Applications to various phases of industry are discussed. CBJ (6)

Progress Report on Hot-patching Cements. A. J. DALE & V. HACKNEY. *Transactions Institution of Gas Engineers,* Vol. 79, 1929-30, pages 240-253. Using ball clay or a siliceous fireclay or low plasticity, disrupture or powdering occurs with less than 70% grog when H_2O is used as an agent of plasticity. Machine oil, glucose, Na silicate (liquid) or cellulose liquor (best) as plasticizers gave marked improvement. Fifty % grog thru 30 mesh is the minimum for hot-patching purposes providing cellulose liquor is used. The order of decreasing efficiency of grogs was carborundum, "aloxite" (electrically fused bauxite), fire-brick, crushed silica brick and raw quartzite. The modulus of rupture after heating to 4 temperatures was greater and there was less change in dimensions for a mixture with cellulose liquor than with H_2O. AHE (6)

1

New Type Checker Brick gives more Efficiency to Stoves in Blast Furnaces. WILLIAM M. BARLEY. *Brick & Clay Record,* Vol. 84, Feb. 1934, pages 56-57. Greater heating capacity is obtained at decreased cost. New designs insure solid wall and eliminate dead flues. The designs include: 1. inlet checker, with large free area to permit easy entrance of gases into flues; 2. top checker, with maximum weight to withstand maximum temperatures and to absorb maximum heat; 3. straight checker, with large heating surface and straight, square flue; 4. ribbed checker, with greatest heating surface per cu. ft. of volume. CBJ (6)

2

Application of Refractories to the Copper Industry. A. G. SUYDAM. *Transactions American Institute Mining & Metallurgical Engineers, Copper Metallurgy,* Vol. 106, 1933, pages 262-277. Reviews use of different refractories in Cu recovery and points out advantages of basic materials, particularly magnesite brick. Typical uses of magnesite brick are shown. JLG (6)

Refractory Materials for Blast-furnaces. ALFRED B. SEARLE. *Metallurgia,* Vol. 9, Jan. 1934, pages 85-86, 88. Discusses requirements for refractories and methods of testing. JLG (6)

3

Heat Losses from Furnace Walls. J. H. WRIGHT. *Iron & Coal Trades Review,* Vol. 126, Mar. 17, 1933, pages 415-416. See *Metals & Alloys,* Vol. 4, Nov. 1933, page MA 367. Ha (6)

Redesigns Electric Furnace for Smaller Capacity. RALPH R. WEST. *Steel,* Vol. 92, June 19, 1933, pages 23-25. See *Metals & Alloys,* Vol. 4, Dec. 1933, page MA 397. MS (6)

Addition of Coke Oven Gas for Open Hearth Furnaces with Producer Gas Heating (Der Koksofengaszusatz bei Siemens-Martin-Oefen mit Generatorgas beheizung) FR. WESEMANN. *Stahl und Eisen,* Vol. 53, Feb. 23, 1933, pages 185-191. Advantages and disadvantages of adding coke oven gas to producer gas for heating open hearth furnaces were studied from experiences in German steel plants. The consensus of opinion was that an increasing addition of coke-oven gas improves the furnace output only when the gas producer plant was too small, but that the heat consumption increases rather than decreases, and that the life of the furnace is shortened, which is attributed to considerable drop in velocity and flowing energy of the flame with increasing coke oven gas addition. Usually only 50% of the required heat energy is supplied by coke oven gas in steel plants. For greater amounts it is recommended to feed the coke oven gas under pressure with high velocity and without preheating. In the discussion it is pointed out that also the time when the coke oven gas is fed influences the economy of the process. It is best done during melting but not in the finishing period. A properly trained personnel is of great importance. Ha (6)

4

Progress in Crucible Melting. G. S. WATSON. *Metal Industry,* London, Vol. 44, Jan. 12, 1934, pages 66-67. Life of melting pots has been increased by addition of certain inert refractory substances to the crucible mixings, and fuel consumption was reduced by paying attention to correct orientation of the graphite flakes in the wall of the pot whereby heat conductivity was increased. Improved methods of firing have made possible also greater sizes of crucibles, units of 1 ton for brass melting are now being used. Ha (6)

5

An Adjustable Blast-Furnace Tuyere *Iron & Coal Trades Review,* Vol. 128, Jan. 5, 1934, page 12. Describes construction and arrangement for blast control by which greater uniformity of temperature distribution in the melting zone can be obtained. See also *Stahl und Eisen,* report of German Iron Masters Association. Ha (6)

6

A New Application of the Surface Combustion Principle. The "Degussa" High Temperature Furnace. *Gas World,* Vol. 98, Feb. 18, 1933, page 15. A detailed description is given of the furnace which is particularly suitable for laboratory and research work, cases where fusions, ignitions, sinterings, decomposition, etc. have to be made. Temperatures which can be used range from 700° to 1850°C. MAB (6)

Measuring the Linear Thermal Expansion of Refractories to 1800°C. *Gas Engineer,* Vol. 58, Nov. 1933, pages 578-583; Dec. 1933, page 625. Testing apparatus and results of Heindl on 7 Cr ores, 4 magnetites, 5 mullites, 2 fire-clay bricks, 2 fire clays, 3 ball clays, 2 kaolins, 3 zircons, and 1 each of spinel, Si-carbide, artificial corundum, diaspore, bauxite, 80% alumina fire brick, silica brick and insulating brick. Analyses are also included. Cr ores showed an exceptionally high expansion between 700° and 1000°C. under reducing conditions. The rest of the materials showed no apparent differences in expansion from 20° to 1000°C. in reducing or oxidizing atmosphere. Magnesites showed the greatest total expansion, the rate of which was nearly uniform. Most materials decreased in weight and length during the tests due to volatilization (probably silica). Cr ores were covered with beads of metal, probably an alloy of Cr and Fe. Tests also included heating cycles. WH (6)

7

Reactivity of Coke (La Réactivité du Coke) Scientific Committee of the Belgian Technical Foundry Association. *La Fonderie Belge,* Vol. 3, Aug. 1933, pages 102-110. Belgian exchange paper at the International Foundry Convention of Prahas. Methods of studying constituents of coal are reviewed. Dilatometric tests are made on coal cylinder of 6.5 mm. diameter located inside of a steel tube of 8 mm. inside diameter. FR (6)

8

Electric Furnace for Annealing Bright Copper Sheets. *Engineering,* Vol. 136, Oct. 20, 1933, page 452. Illustrates and gives short description of a furnace built by Industrie Elektroofen, G. m. b. H., Cologne, Germany. The furnace temperature can be regulated between 250° and 750°C. and maintained to within ± 5°. LFM (6)

New Steel Furnaces of the English Steel Corporation, Ltd *Engineer,* Vol. 156, Sept. 8, 1933, pages 230-232. General description giving diagram showing the arrangement of the plant and sections through the furnaces. LFM (6)

9

Advantages of Artificial Air Movement for Heat Transmission (Vorteile einer künstlichen Luftumwälzung bei Wärmeübertragung) *Elektrowärme,* Vol. 4, Jan. 1934, pages 12-14. Several examples are calculated to show how much the heat transmission to the material in a box-type furnace can be improved when the air is circulated instead of being left to natural circulation. From 4 to 60 times the amount of heat can be transmitted for the same temperature gradient according to the nature of the material. Ha (6)

10

Fuel Comparisons for Billet Reheating Furnaces. G. W. AKERLOUV. *Gas Age-Record,* Vol. 72, July 29, 1933, pages 103-106. In reheating steel billets preparatory to rolling the main consideration of the mill man is the cost of heating per ton of coal. A detailed analysis of a comparative test of coal, fuel oil and gas on a reheating furnace using 2" x 2" x 32" open hearth steel billets at a temperature of 2500-2700°F. and using the same furnace crew showed a cost of heating steel per net ton of $3.13 for coal, $5.65 for fuel oil and $5.13 for gas. To make gas firing successful, automatic control of fuel supply and temperature is essential. With coal firing furnace maintenance is higher and additional labor is necessary. VVK (6)

Electric Salt Baths (Elektrische Salzbadeöfen) *Elektrizitätswirtschaft*, Vol. 32, Nov. 15, 1933, pages 492-493. Advantages of electric heating are listed. Three types of salt baths are described: (1) indirectly heated, (2) directly heated salt baths (3) electrode salt baths with ceramic lining. (1). Main utilization: case hardening in cyanide salts, working temperature: 950°C., power input: 3.9-180 kw, time for heating up to temperature when cold: 2.5-3.5 hrs., bath content: 1.4—890 liters. (2). Maximum furnace temperature: 1000°C., 20-60 kw, shorter heating times than (1), use: hardening and carburizing. (3). Max. temperature: 1350°C., 20-70 kw., utilization: high speed steel treatment. WH (6)

Chrome-Base Castable Refractory Shows Merit in Steel Heating Furnaces. *Steel*, Vol. 94, Feb. 12, 1934, page 28. See "Furnace Bottom Refractory," *Metals & Alloys*, Vol. 5, Jan. 1934, page MA 35. MS (6)

Heat Treatment Furnaces. *Automobile Engineer*, Vol. 23, June 1933, pages 215-218; July 1933, pages 241-244. Rather general article discussing and illustrating various gas and electric furnaces of British makes. Considers design, details and opinion. Mentions a few applications but does not include specific directions for heat treatment. RHP (6)

New Ceramics of Pure, Highly Refractory Oxides (Neue Keramik reiner, hochfeuerfester Oxyde) E. Ryschkewitsch. *Elektrowärme*, Vol. 4, Feb. 1934, pages 30-31. The particular difficulties in using metal oxides with very high melting points as refractory materials due to their low plasticity and deformability are discussed. Most used is Al_2O_3 in the system Al_2O_3/SiO_2; its melting point is 2050°C. and it is at present possible to make a very dense product which is absolutely dense even at 1800°C. and chemically permanent. Pyrometer tubes are made of it. BeO is still superior, melting temperature is 2500° and its chemical stability very great especially against reducing influences; also the electric resistance of the material is still higher than Al_2O_3. It must, however, be protected at high temperatures from contact with other oxides as easily melting compounds might be formed. ZrO_2 is practically not attacked by strongly acid and strongly basic substances, C, H, sulphuric vapors. Objects made of ZrO_2 can be used up to 2500°C., it is not quite as dense as Al_2O_3 or BeO; the electric conductivity is considerably higher as in other pure refractory oxides. At high temperatures ZrO_2 forms with C carbide at the surface which, however, oxidizes again to ZrO_2. Magnesia has 96-97 MgO content; bricks can be used up to 2400°, they show at 2000° under a pressure of 2 kg./cm.^{2} no softening if made from pure material. MgO apparatus are particularly suitable for use with basic slags, melting of Pb, etc. ThO_2 has the highest melting point with 3000°C., sp. gr. about 10, and is resistant to basic substances. High thermal expansion coefficient and low temperature conductivity are a drawback. Zirconium silicate ($ZrSiO_4$) and Spinell ($MgOAl_2O_3$) are used for apparatus crucibles, tubes, etc. for temperatures up to 1750 and 2000°C. resp. Ha (6)

Induction Melting Furnaces A. G. Robiette. *Iron & Coal Trades Review*, Vol. 128, Feb. 16, 1934, page 285; Feb. 23, 1934, pages 332-333. Induction furnaces are used to advantage for melting non-ferrous materials (brass, nickel-silver, etc.), and also for superheating gray cast iron; if introduced from a cupola at about 1350°C. it will superheat at 1550°-1600° at as low as 60 kw. hrs. per ton which is about 60% of that for an arc furnace. The most recent and now widely used type is the coreless induction furnace with 500-3000 cycles. Simple construction and small weight of refractory material are its principal features, but the power factor is naturally low, 0.08-0.1, and is usually improved by a bank of condensers. Operation, pinch effect, regulation of stirring by it, lining materials and constructive details are briefly mentioned, continuous and batch type furnaces, advantages of forced air circulation discussed. Ha (6)

Experiments with Addition of Naphtha to the Firing of Cupola Furnaces (Versuche mit Naphthazusatzfeuerung an Kupolöfen) Wilhelm Schneider. *Die Giesserei*, Vol. 21, Mar. 2, 1934, pages 98-100. In order to replace coke which contained 2.5-3.6% S. for melting in a cupola successful experiments were made with naphtha which was available in large quantities. The amount of coke could be reduced to 15 kg. for each 100 kg. Fe charge when 1 kg. naphtha was used. The hourly melting capacity increased from 3.5 to 5.5 tons, the time of annealing could be reduced from 208 to 136 hrs. so that great savings in time and better utilization of the annealing department and savings in naphtha were realized. Ha (6)

Calodur Furnace (Der Calodur Ofen) Hans Sauer. *Brown Boveri Nachrichten*, Vol. 20, Oct./Dec. 1933, pages 138-139. Calodur is a special porcelain-like refractory possessing excellent heat conductivity and is a good electric insulator. Calodur heating elements permit simplification of construction of electric heating and hardening furnaces. Special advantages: low weight, low power consumption and uniform temperature distribution. It takes but about 2½ hrs. to heat a new dried furnace to the maximum service temperature of 1000°C. Current losses at this temperature amount to about 1.7 kw. with a heating surface of 3.39 m.^{2} GN (6)

Improved Igniting Electrode for Salt Bath Hardening Furnaces (Verbesserte Zündelektrode für Salzbadhärteöfen) *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 24, Jan. 14, 1934, page 20. In igniting electrodes are short circuited by Fe resistances that liquefy frozen bath within short time. Further advantage: simple attendance of a salt bath furnace. GN (6)

Account of the "Pulverized Coal Day" (Journée du Charbon Pulvérisé) E. M. *La Technique Moderne*, Vol. 25, Jan. 1933, pages 14-17. Two of summarized papers deal with metal treatment (1) "Use of pulverized coal in the manufacture of cast Fe" by M. Frion and (2) "Use of pulverized coal in rotary melting furnace" by Goffard and Boussard. FR (6)

Improves Wire Baker Economy with Refractory Combustion Chamber. *Steel*, Vol. 93, Sept. 18, 1933, page 32. Combustion chamber made from tongue and grooved silicon carbide tile replaced one constructed of castings, which were found to warp. MS (6)

Properties of Rolled Plates Improved by Heat Treating. *Steel*, Vol. 92, June 5, 1933, page 33. Worth Steel Co., Claymont, Del., has installed an oil-fired continuous furnace, 50 ft. long in the mill tables midway between the main rolls and the straightening rolls. All plates rolled on the mill now pass through the furnace, resulting in improved physical properties and flatness. MS (6)

Oblique Rear Walls for Open-Hearth Furnaces (Anwendung schräger Rückwände bei Siemens-Martin-Oefen) *Stahl und Eisen*, Vol. 53, Jan. 19, 1933, pages 77-78. The arrangement of the rear wall of an open-hearth furnace at an angle of 60°-70° has been tried several times. Experiences in different plants show that advantages due to easier repairs are offset by increase of volume and arch of the furnace which often means increased fuel consumption. A few construction details and costs of operation are given. Ha (6)

Energy Problems in the Iron and Steel Industry. *Iron & Coal Trades Review*, Vol. 127, Aug. 18, 1933, page 245. A few papers pertaining to this subject and read before the World Power Conference are reviewed and discussed. To save and better utilize energy in fuels some large works recently have started to use the valuable coke-oven gas, instead of firing it partly in the coke-ovens, only in places where higher temperature is required than in coke-ovens. They fire the latter by the poorer blast furnace gas. The use side by side of coal, powdered coal and blast furnace gas must be considered according to conditions, layout of the works and gas transportation lines. Diffusion combustion for natural gas and possibly coal gas seems to promise a better utilization of the heat content of the gases. Hereby gas and air are not mixed but move in parallel currents, the combustion taking place in the beginning only at the surface of contact. Further inside the gas layer incomplete combustion occurs with a decomposition of the hydrocarbons so that free particles of carbon are formed and a long, incandescent flame is obtained which gives a very efficient heat transfer by radiation while the formerly used flameless surface combustion did not transmit the heat very effectively and the radiation from the furnace walls heated the material in the furnace. Ha (6)

JOINING (7)

Rolled Couplings (Walzverbindungen) E. Siebel. *Stahl und Eisen*, Vol. 53, Nov. 23, 1933, pages 1205-1215. An account of the method of making tight, strong, and permanent joints in boiler tubes, etc., by expanding the ends with a mandrel and interior rolls. SE (7)

Soldering & Brazing (7a)

C. H. CHATFIELD, SECTION EDITOR

Continuous Furnace Brazing of Steel Assemblies in Reducing Atmosphere. C. L. West. *Fuels & Furnaces*, Vol. 11, May-June 1933, pages 97-104; *Steel*, Vol. 93, Oct. 23, 1933, pages 25-28. See "Assembly of Steel Stampings by Continuous-Furnace Brazing," *Metals & Alloys*, Vol. 5, Feb. 1934, page MA 54. Ha + MS (7a)

Silver Solders (Silberlote) W. Stein. *Mitteilungen des Forschungsinstituts und Probieramts für Edelmetalle*, Vol. 7, Oct. 1933, pages 80-87; Nov.-Dec. 1933, pages 97-103. The field of silver solders and the demands made on them in the rare metal and jewelry industry is reviewed. Compositions of solders of Ag-Cu-Zn-Cd-Sn, Ag-Cu-Sn-Zn-Al, Ag-Sn-Zn, Ag-Cu-Sn-Zn-Sb-Al, Ag-Cu-Zn, their melting and freezing points, range of applications, and physical and mechanical properties are given in tables; the original must be referred to for details. Ha (7a)

Proper Soldering (Richtiges Löten) *Deutsche Goldschmidezeitung*, Vol. 37, Jan. 13, 1934, pages 35-36. In discussed rule sheet of Deutsche Gold- und Silber-Scheideanstalt correct and wrong methods of soldering are compared. Faults made are enumerated in order of frequency. These are the incorrect fitting of parts, the use of too little or too much solder, the use of unsuitable flux, and the use of a poor soldering flame. GN (7a)

Soldering and Brazing. Arthur S. Newman & R. S. Clay. *Journal of Scientific Instruments*, Vol. 10, Nov. 1933, pages 333-338. A discussion of various fluxes and the many mechanical operations of soldering and brazing various metals. RAW (7a)

Welding & Cutting (7b)

C. A. McCUNE, SECTION EDITOR

The Place of Shape-Cutting in Industry. *Oxy-Acetylene Tips*, Vol. 12, Aug. 1933, pages 173-175. Oxy-acetylene shape-cutting machines and their operation are described; the advantages in the use of parts cut from fabricated plates are that the superior physical properties and uniformity of hot-rolled steel are fully utilized, better local distribution of material can be obtained, reduction of weight without sacrifice of strength, reducing of machining, as the shape is cut to extremely close tolerances, and waste as compared with castings is almost eliminated. A number of examples of heavy machinery parts is given Ha (7b)

Welded Connections in Structural Work (Gelaschte verbindingen in ijzerconstructies) *Polytechnisch Weekblad*, Vol. 27, Aug. 17, 1933, pages 520-521. 9 different possibilities of connecting girders with the aid of welding are illustrated and discussed. WH (7b)

Spot Welding the Stainless Steels. V. W. Whitmer. *Iron Age*, Vol. 130, Sept. 29, 1932, page 498; *Steel*, Vol. 92, Feb. 20, 1933, page 23. See *Metals & Alloys*, Vol. 4, Nov. 1933, page MA 356. VSP + MS (7b)

Development of Electric Spot-Welding Machines (Entwicklung der elektrischen Punktschweissmaschinen) E. R. Ruck. *AEG-Mitteilungen*, July 1933, pages 122-125. Single and multiple spot welding machines as used in the manufacture of small hardware are described. Ha (7b)

The Copper Hydrogen-Electric Welding Process. T. M. Rude. *Mill & Factory*, June 1933, pages 41-42. See "Assembly Involving Many Welds now Produced in Single Operation," *Metals & Alloys*, Vol. 4, Dec. 1933, page MA 390. Kz (7b)

Fusion Welding in the Manufacture of Automobiles (La Soudure autogène en Construction automobile) M. Salelles. *L'Usine*, Vol. 42, Mar. 31, 1933, page 31. The determining factors for the selection of the type of welding to be applied in certain problems are discussed and briefly illustrated by examples. Ha (7b)

Welded Welding Dynamos (Geschweisste Schweissdynamos) E. Rosenberg. *Elektrowärme*, Vol. 3, Dec. 1933, pages 372-374. Details of construction for quantity production are described and illustrated. Ha (7b)

Automatic Carbon Arc Welding (Automatische Kohle-Lichtbogenschweissung) E. Rosenberg. *Elektrowärme*, Vol. 3, Nov. 1933, pages 336-340. Carbon-arc welding is particularly advantageous for welding thin tubes, and an automatic welding process is now applied also for welding of plates of 10 mm. and more. The C arc is less sensitive to changes in length than the metal arc, short-circuits between arc and metal are less frequent as there is no metallic drop from electrode to piece. Certain pastes are used in welding to prevent oxidation and nitriding of the hot material by the atmosphere so that the weld has good mechanical properties. For welding 1 mm. sheets a C electrode of 3-4 mm. is used and a current of 40 amp. or higher. Welding equipment is described and many examples of different machines are illustrated. Ha (7b)

Recent Applications of the Arcatom Welding Process (Neuere Anwendungen des Arcatom-Schweissverfahrens) Fr. Rosenberg. *Elektrowärme*, Vol. 3, Nov. 1933, pages 340-342. Examples of repairs and built-up parts are described. Ha (7b)

Stresses in Welded Seams (Spannungen in Schweissnähten) L. v. Roessler. *Autogene Metallbearbeitung*, Vol. 26, Sept. 15, 1933, pages 273-279. A properly made weld must show agreement of structure and properties of the weld with the parent material, no zones of overheating next to the weld and freedom from internal stresses. These conditions can usually be obtained by proper welding methods and annealing of the welded piece above the upper transformation point, i.e. above 900° C. Internal stresses can occur due to plastic deformation of the material on account of sharp local heating when welding and to contraction of the seam and material under cooling. These conditions were investigated experimentally; the stresses and their distribution parallel and transversely to the seam were measured by tensometers. Longitudinal stresses of 1060 kg./cm.^{2} with left-hand gas welding to 1800 kg./cm.^{2} for electric welding with bare electrodes were measured while transverse stresses were 2700 and 1960 kg./cm.^{2} respectively for the same welding methods when the 2 pieces were rigidly held, and 1700 to 300 kg./cm.^{2} when the parts could move a little under welding. Longitudinal stresses can be reduced by keeping the seam warm for a short time; the experiment showed after 2 minutes a considerable reduction, 1350 to 800 kg./cm.^{2}. Ha (7b)

New Clamp for Welding Longitudinal Tank Seams (Neue Spannungsvorrichtung zum Schweissen von Behälterlangsnähten) O. Röthlin. *Zeitschrift für Schweisstechnik*, Vol. 23, Oct. 1933, pages 256-259. Detailed illustrated description of a device for holding cylinders for welding thin or thick plate. The device overcomes the tendency of the cylinder to flatten along the joint during welding. RRS (7b)

New Process for Straight, Miter, and Curvilinear Cutting of Pipe (Neue Schneidvorrichtung für gerade, Durchdringungs, und Gehrungsschnitte an Rohren) O. Röthlin. *Zeitschrift für Schweisstechnik*, Vol. 23, Sept. 1933, pages 233-235. Pipe cutting has heretofore been done by sawing. The oxy-acetylene cutting apparatus that is described in this article effects a great saving in time and effort required for this work; by its use, a 1¼" pipe may be given a straight cut in 20 seconds, a curved cut in 30 seconds, or a miter cut in 35 seconds. RRS (7b)

Fusion Welding and Welded Constructions in the Design of Chemical Apparatus (Schmelzschweissung und Schweisskonstruktionen im chemischen Apparatebau) Hugo Schroeder. *Werkstoffe und Korrosion*, Vol. 8, Aug. 25, 1933, pages 29-31; Sept. 25, 1933, pages 34-35; Nov. 25, 1933, pages 41-42. Development of oxy-acetylene and electric welding in the construction of metal apparatus in particular for the chemical industry, gas producers, welding machines and metallurgical reactions going on in the welding process are discussed and explained. Ha (7b)

Devices for Welding of Corner Seams (Vorrichtung zum Schweissen von Ecknähten) H. Schulz. *Autogene Metallbearbeitung*, Vol. 26, Mar. 1, 1933, pages 71-72. Templates and jigs for welding the corners of sheet boxes are described and illustrated. Ha (7b)

New Possibilities by Acetylene Welding (Neue Arbeitsmöglichkeiten durch Azetylenschweissung) H. Schulz. *Autogene Metallbearbeitung*, Vol. 26, Oct. 15, 1933, pages 308-311. Examples of making and repairing small hardware, railing, tools, etc., are illustrated. Ha (7b)

Recent Developments in Cutting Steel with Oxygen. J. R. Stewart. *Iron & Steel of Canada*, Vol. 16, May-June 1933, pages 73-75. Abstract of paper presented before Montreal Chapter, A.S.S.T., with 5 illustrations showing recent uses of oxygen torch in machine-cutting, scarfing, rivet-cutting, lance-cutting, and flame-machining. OWE (7b)

Welding of Pipes by Electric Resistance Method. P. M. Shuvalov & N. P. Spiridonov. *Domez*, 1933, No. 5-6, pages 1-14; No. 7, pages 4-13. (In Russian.) Survey of electric welding methods for pipe making and machines used for it. U. S. machinery is discussed but one German and one Czechoslovakian are described. In a Russian invention pipe blank is fed between two pairs of contact rolls. Both are poles of transformer. Blank is heated by passage of the current through it and brought to welding heat by additional circuit formed by proper wiring in the second pair of rolls. The latter are spaced closer which effects the joint. Testing of some tubes of Russian manufacture showed their poor quality. (7b)

The Modulation Method, a New Method of Welding of Seams (Das Modulationsverfahren, eine neue Methode das Nahtschweissens) E. Rietsch. *AEG-Mitteilungen*, July 1933, pages 125-138. This method is actually a rapid spot-welding whereby the individual spots follow each other in such rapid succession that a continuous seam is obtained. The material to be welded passes through roller contacts. The impulses for the spots are produced by a modulator, which is in principle a single-phase rotating transformer which changes the voltage supplied to the welding machine periodically from a minimum to a maximum according to its speed of rotation. The roller contacts keep much cleaner in this way than with continuous welding. Examples are given. Ha (7b)

Calculation of the Capacity of Resistance Welding Machines (Die rechnerische Ermittlung der Leistung elektrischer Widerstandsschweissmaschinen) Eberhard Rietsch. *Die Elektroschweissung*, Vol. 4, Sept. 1933, pages 161-166. A calculation method is developed for the changing load of the transformers of electric resistance welding machines. In the formula derived the permissible number of welded spots in unit time which is limited due to heating up of the insulating material is expressed by simple measurements. The various chapters consider: (1) derivation of formulae for intermittent operation, (2) simplification of calculation for practical use, (3) practical application of formulae to transformers for spot welding, (4) practical application to butt welding machines. Other types of welding than those considered in paper offer no difficulties in calculation. No more difficult is application of calculation to related fields such as that of arc welding transformers. GN (7b)

Automatic Devices for Carbon Arc Welding (Selbsttätige Einrichtungen für Kohlelichtbogenschweissung) Carl Ritz. *Siemens-Zeitschrift*, Vol. 13, July/Aug. 1933, pages 150-153. Electrode holders, feeding arrangements and auxiliary apparatus of the Siemens-Schuckertwerke are described and some of the welded products illustrated. Ha (7b)

The Development of Carbon Arc Welding (Die Entwicklung der Kohlelichtbogen-Schweissung) K. Ruppin. *Die Elektroschweissung*, Vol. 4, Dec. 1933, pages 233-236. Author gives in chronological order patents taken in Germany, France, Austria, England and U.S.A. in welding with carbon arc. Principal characteristics of the various welding methods are outlined. The paper clearly sets forth the ways and means devised in developing a suitable welding method and a reliable method of stabilizing the arc. GN (7b)

Welding in the Steel Industry—Construction of Welded Steel Rollers. C. M. Taylor. *Iron Age*, Vol. 131, Apr. 20, 1933, pages 620-621. First of a series of four articles. Describes briefly the fabrication of water-cooled disk rollers for heating and annealing furnaces, as well as of common-type table rollers, finishing train rollers and transfer table rolls. VSP (7b)

An Introduction to Welded Structures. G. J. Voce. *Structural Engineer*, Vol. 11, June 1933, pages 274-289; July 1933, pages 320-335. Paper before the Midlands Counties Branch of the Institution of Structural Engineers, Mar. 1933, considers at length the characteristic features of the various welding processes, specializes on residual stresses with reference to various kinds of joints suited for structural steel work, and compares the specifications according to standard German, American and Australian codes. The second installment of the paper goes into very great detail of structural design based on welding. Many practical features can be taken from 12 charts containing a great number of illustrations. In conclusion, inspection and testing are briefly dealt with. WH (7b)

Fusion Welding (Autogenes Schweissen im Handwerk) E. Zorn. *Autogene Metallbearbeitung*, Vol. 26, Oct. 15, 1933, pages 306-308. Advantages of fusion welding in the many different requirements of joining metals in small plants and shops are pointed out. Ha (7b)

Application of the Electric Welding in Locomotive and Car Repair Shops. Kan-ichi Yamaguchi. *Journal Society of Mechanical Engineers Japan*, Vol. 36, July 1933, pages 472-476. Paper read before the Society of Mechanical Engineers, Machine Tool Section, Jan. 23, 1933. Discussion of (1) specialties of electric welding, (2) electrodes, (3) welding machines, (4) comparisons with riveting and gas welding from the economical viewpoint, (5) the effect of the C content on deposited metal, (6) abrasion properties of deposited metal, (7) training of welders. Kz (7b)

The Physics of Electric-Arc Welding. E. Westman. *Mechanical World & Engineering Record*, Vol. 93, July 28, 1933, pages 725-727. In producing a stationary arc the ability of a hot cathode to emit electrons is made use of. The stream of electrons disrupt the air and increase the conductivity of the gap. The voltage required depends on the material, the arc length, and the magnitude of the current. For arc welding with alternating current of common frequencies, flux-coated electrodes are used in order to keep the arc stable. Kz (7b)

Short Circuit Current and Dynamic Idling Voltage of Welding Generators (Stosskurzschlussstrom und dynamische Leerlaufspannung beim Schweissgenerator) Artur Waclawik. *Die Elektroschweissung*, Vol. 4, Dec. 1933, pages 121-127. The effect of machine sluggishness on the steadiness of the electric arc and the measures required for a rapid actuation of shunted machines are considered. GN (7b)

Acetylene Welding as Used in Modern Refrigeration (Azetylenschweissung als Konstruktions Element in der modernen Kaltetechnik) H. Schneider. *Forschungsarbeiten auf dem Gebiete des Schweissens und Schneidens mittels Sauerstoff und Azetylen*, Series 8, 1933, pages 37-47. See *Metals & Alloys*, Vol. 4, Dec. 1933, page MA 388. Ha (7b)

Strength of Fusion Soldered Seams in Mild Steels (Propieta resistenti delle saldature autogene su acciaio dolce) G. Sirovich. *La Metallurgia Italiana,* Vol. 25, July 1933, pages 502-524; Aug. 1933, pages 569-598; Sept. 1933, pages 653-672; Oct. 1933, pages 725-740. The strength of soldered joints, soldered by means of the electric arc, oxyacetylene flame, and water gas flame, by fusion alone, or fusion with pressure, have been determined on over 5000 samples. Mechanical tests, as well as macro- and microscopic examinations were made on all samples, over 150 photographs being taken, 48 of which are shown in the article. No method using fusion alone was wholly satisfactory, only when pressure is used in addition, are satisfactory results obtained. The water gas flame was found to give the best results. AWC (7b)

Modern Electric Welding Technique in Road and Auto Construction (Die moderne elektrische Schweisstechnik im Strassen- und Autobau) K. Ruppin. *Elektrowärme,* Vol. 3, Nov. 1933, pages 343-344; Dec. 1933, pages 361-364. The possibilities of electric welding for construction of reinforced concrete road beds for automobile highways as planned in Germany and for automobiles themselves are discussed. Ha (7b)

Filler Materials for Acetylene Welding of Steels (Ueber Zusatzstoffe für die Azetylenschweissung von Stahl) E. Streb & H. Kemper. *Forschungsarbeiten auf dem Gebiete des Schweissens und Schneidens mittels Sauerstoff und Azetylen,* Series 8, 1933, pages 56-63. See *Metals & Alloys,* Vol. 4, Aug. 1933, page MA 258. Ha (7b)

Burning through Metal Barriers Under Water (Het onderwater snijden van metalen deelen) R. G. Skerrett. *Polytechnisch Weekblad,* Vol. 27, June 29, 1933, page 410. See *Metals & Alloys,* Vol. 4, Nov. 1933, page MA 356. WH (7b)

Copper and Copper Alloy Welding Rods. W. C. Swift. *Industry & Welding,* Vol. 5, May 1933, pages 21-23. A brief history of welding and development of welding methods and tools. Bronze welding is widely used for malleable iron, steel tanks, cast iron, etc. Principal advantage of welding with a bronze rod instead of with a filler of the same material is that the weld is more ductile and that costs for welding are lower due to savings in O, C_2H_2 and time. Ha (7b)

Gas Holder Repairs and Electric Arc Welding. J. G. Pope. *The Gas Engineer,* Vol. 58, Oct. 1933, pages 521-523. The possibilities of electric arc welding are demonstrated on the repair of a 550,000 cu. ft. capacity gas holder which exhibited serious corrosion defects. WH (7b)

Construction of Welded Gondolas for Stratospheric Balloons. Jean Piccard. *Welding Engineer,* Vol. 18, June 1933, pages 30-31. Pure Al was selected as material on account of lightness, ease of welding and resistance to mechanical injuries without breaking. A second gondola is made of Dowmetal consisting of about 95% Mg and the remainder mostly Al. Density is 1.8 against 2.7 for Al. It is not weakened by welding and is stronger than Al. Procedure of welding is briefly described. Ha (7b)

Electric Welding in Naval Engineering. The Shrinkage Problem (La Soudure Electrique en Construction Navale. Problème du Retrait) J. Piczon. *Science et Industrie,* Vol. 17, July 1933, pages 316-320. A theoretical study aiming at the establishment of the law governing the distribution of heat inside of a plate during the welding operation. Examples of numerical application for the formula sought for are given. Practical conclusions can already be drawn from this heat distribution law. The following stage of the study will comprise the influence of this distribution on the expansion or shrinkage of the metal and, consequently, on the residual tension or compressive stresses. FR (7b)

Heating Parts Before Welding. C. C. Phares. *Transit Journal,* Vol. 77, Nov. 1933, pages 411-412. Preheating, before welding, to insure a uniform temperature throughout the entire piece and allowing to cool slowly after the welding operation reduces local stresses to a minimum and eliminates cracks. The Akron Transportation Co., Akron, Ohio, has erected an oven with heavy iron sides and bottom made from a scrapped old railroad dump car. WHB (7b)

Bronze Welding Broken Locomotive Cylinder. J. B. Patterson. *Industry & Welding,* Vol. 5, Mar. 1933, pages 14-15. Extensive cracks around the valve chamber were successfully welded with bronze after preheating. Ha (7b)

Electric Welding in the Construction of Finnish Warships. J. Rahola. *Welder,* Vol. 5, Oct. 1933, pages 4-7. Constructive details are described and illustrated. Ha (7b)

Acetylene-Welded Factory Gate (Azetylengeschweisstes Fabriktor) W. Raabe. *Autogene Metallbearbeitung,* Vol. 26, Nov. 1, 1933, pages 327-328. Describes procedure. Ha (7b)

Fusion Welding Instead of Riveting on a Refractory Door (Autogenschweissung anstatt Nietung an einer feuerfesten Tür) W. Raabe. *Autogene Metallbearbeitung,* Vol. 26, Oct. 15, 1933, pages 316-317. Door of 1 x 3m. of 2 and 4 mm. steel sheets. Describes procedure. Ha (7b)

Factors Governing the Choice of Electrodes. Wayne A. Howard. *Sheet Metal Industries,* Vol. 7, Aug. 1933, pages 252, 254; Sept. 1933, pages 314, 317. From a paper presented before the Los Angeles Section of the American Welding Society. The author discusses physical properties and coatings listing four variables to be considered. A work value is suggested based on tensile strength, yield point, elongation, Charpy impact, density, fatigue limit, reduction of area, and ductility by the free bend test. Having assigned weighted values to each of these factors, a factor of merit is determined by dividing the work value by the price per pound of the welding wire. There is a possibility of comparing efficiency and uniformity by using a melting coefficient (unit—grams-per-ampere-minute). AWM (7b)

Electric Welding of Gray Cast Iron (Beitrag zur Ausführung elektrischer Graugusswarmschweissungen) Titscher. *Die Elektroschweissung,* Vol. 4, Oct. 1933, pages 194-196. After discussing disadvantages of common methods of welding gray cast Fe author devised new method successfully tested on large castings such as steam engine cylinders, tool lathe, etc. Largest part of welding material is melted in small portable muffle while base of seam is liquified by electric arc. Oxidation loss of Si, Mn, Cr is higher. Melting points of work piece metal and metal added should be similar. High contents of Ni and Cr should be avoided, melting points being too high. Method gave porefree welds of high quality, showing fine structure rather free of graphite. GN (7b)

Teaching Metallic Arc-Welding. E. Tutt. *Welder,* Vol. 4, Apr. 1933, pages 28-31. Suggestions for practical welders, designers or draftsmen are made and a few instructions for watching the progress made by pupils are added. Ha (7b)

The Electric Welding of High-Chromium Steels. F. C. Thompson. *Welder,* Vol. 4, May 1933, pages 13-15. High Cr stainless steels cannot be satisfactorily welded by oxy-acetylene or gas flames on account of the oxide formed on the weld. Most suitable is the atomic hydrogen process due to the high temperature attainable together with the elimination of appreciable oxidation or carburization. Composition of weld deposit should be as near as practicable to that of material to be united. Electrode should therefore consist of a core of steel similar in composition to the work and have an asbestos wrapping to act as a flux and steady the arc, together with a mixture of a reducing nature which contains ferro-chrome. The metallurgical condition of the weld with varying welding temperatures is discussed briefly. Ha (7b)

Forming of Pipes by Welding (Rohrverbindung durch Schweissnaht) H. Thomas. *Autogene Metallbearbeitung,* Vol. 26, July 1, 1933, pages 193-198. Various kinds of welding for joining pipes to pipe lines are discussed and illustrated. Main object is to obtain a joint free of stresses. Ha (7b)

Machine-Welding by the Arcatom Process (Maschinelles Schweissen nach dem Arcatom-Verfahren) E. Thiemer. *AEG-Mitteilungen,* July 1933, pages 131-133. Welding apparatus for H in connection with electric arc welding is described and good results obtained, especially for pipe welding, illustrated by examples. Ha (7b)

Automatic Electric Arc-Welding Machines of the A. E. G. (Lichtbogen-Schweissautomaten der A. E. G.) E. Thiemer. *AEG-Mitteilungen,* July 1933, pages 129-131. Describes operation and control apparatus. Ha (7b)

Welded Piston Cylinders for Locomotive. A. Pechkin. *Welding,* No. 5, 1933, pages 14-16 (In Russian). Piston cylinders with supplementary parts were made of boiler plate by welding as a one piece job requiring 186 parts. It was made successfully, but was not tried in practice. (7b)

Rolling Stock Repair by Welding. *Railway Engineer,* June 1933, pages 182-183. Building up worn flanges by automatic arc-welding on the Italian State Railways, and welding practices of the Egyptian State Railways. WH (7b)

Continuous Rail Welding in Germany. *Railway Engineer,* Aug. 1933, pages 239-240. Continuous rails of exceptional length obtained by welding are being used for tunnel relaying on the German State Railways, a notable example of which is described. The type of flash-butt welding machine employed for the end-to-end welding of the rails in the depot is fully considered. The ends of the rails are held in the copper jaws connected to the low-voltage and high-current secondary of a single phase transformer, and slowly moved up together automatically. From the behavior of the rail train carrying the welded rails it would appear that "rails of indefinite length could be conveyed in the same way without risk." The few welds made in the tunnel were accomplished by the Thermit process. Detailed cost sheet is given. WH (7b)

Use of Monel Metal to Obtain Machineable Welds on Cast Iron (Emploi du métal Monel pour obtenir des soudures usinables sur pièces de fonte) *Revue du Nickel,* Vol. 4, July 1933, pages 92-94. Use of Monel metal electrodes for arc welding eliminates that region of great hardness generally found when cast iron is welded with cast iron or steel electrodes. The welding must be made on cold parts and the welds must be carefully hammered. Monel metal can also be used for blowpipe welding if the parts are preheated and the melt completely covered by the flux. AH (7b)

Fusion Welding of Copper. The Oxide and Its Eutectic (La clef du problème de la soudure autogène du cuivre. L'oxydule et son eutectique) *Le Soudeur-Coupeur,* Vol. 2, Nov. 1933, pages 1-4. A phenomenon that occurs in all attempts to weld copper is the transformation of the oxide inclusions to oxide eutectics; it was first demonstrated by Le Grix in 1922. With this discovery it became apparent that use of copper free from oxide would make satisfactory welding possible. Micrographs show that commercial coppers almost invariably contain grains of oxide. The eutectic occupies much more space than the oxide and the result is a fragile piece. RRS (7b)

Construction and Repair of Copper Locomotive Fireboxes (Construction et réparation de foyers en cuivre de locomotives) *Le Soudeur-Coupeur,* Vol. 12, Nov. 1933, pages 18-24. Cooling of riveted fire boxes proceeds unequally and results in rapid deterioration of joints. With welded joints, cooling occurs much more evenly. Describes in detail the method for repairing breaks in various parts of a copper fire box. RRS (7b)

Advantages and Safety of Fusion Welding on Copper Boilers (Advantages et sécurité de la soudure autogène dans la chaudronnerie de cuivre) *Le Soudeur-Coupeur,* Vol. 12, Nov. 1933, pages 11-17. Details of fusion welded boilers and pressure vessels. The joint is made by welding overlapping toothed ferrules. In a test, a spherical vessel fabricated in this way withstood a pressure of 50 kg./cm.[2] RRS (7b)

How to Weld Copper with the Torch (Comment souder le cuivre au chalumeau) *Le Soudeur-Coupeur,* Vol. 12, Nov. 1933, page 5. It is easy to weld small bits of copper, but large pieces present difficulties because of the great heat conductivity, low strength when hot, and the great fluidity of copper in the molten state. It is necessary to select the torch with reference to the mass as well as the thickness of the metal to be welded. RRS (7b)

Fusion Welding of Copper Tubes and Ferrules (Exécution par soudure autogène de tuyaux et de viroles en cuivre) *Le Soudeur-Coupeur,* Vol. 12, Nov. 1933, pages 6-10. Description of welded copper tubes, including straight, s-shaped, t, and y-tubes. Details of the method, and time and material consumption data are given. RRS (7b)

Stainless Steel Acid Resistant Apparatus in Japan (Les appareils à acide en acier inoxydable au Japon) *Le Soudeur-Coupeur,* Vol. 12, Sept. 1933, pages 4-6. Detailed description of container and coil of stainless steel assembled by welding. Tables give the details of the welds and data on the material consumed. RRS (7b)

Modernization of Agricultural Equipment (La modernisation du matériel rustique) *Le Soudeur-Coupeur,* Vol. 12, July 1933, pages 8-9. Plan and description of welded steel wagons. RRS (7b)

Oxy-acetylene Cutting (L'oxy-coupage) *Le Soudeur-Coupeur,* Vol. 12, June 1933, pages 1-24. The June issue of this magazine consists of a series of 12 articles on oxy-acetylene cutting; its principles; its use in demolition of steel structures and in the removal of rivets, etc. RRS (7b)

Structural Welding (Die Schweissung in Stahlbau) *Zeitschrift für Schweisstechnik,* Vol. 23, July 1933, pages 187-188. Equations for design of structural steel in tension, compression, and sheer for both butt and fillet welds. RRS (7b)

Comparison of the Costs of Pressure Vessels Fabricated by Fusion Welding (Kosten-Vergleich eines Druckgefässes, ausgeführt durch autogene und elektrische Schweissung) *Zeitschrift für Schweisstechnik,* Vol. 23, June 1933, pages 156-161; July 1933, pages 177-180. Details of a pressure vessel and of an oil tank. Description of the methods of fabrication. Detailed cost analyses for oxy-acetylene and electric welding. RRS (7b)

Built-up Repairs in Cast Iron. (Auftragsreparatur-Schweissung an Grauguss) *Zeitschrift für Schweisstechnik,* Vol. 23, July 1933, pages 189-190. Brief illustrated description of built-up welded repairs on a cast iron carriage and on a cast iron motor casing. RRS (7b)

Fusion Welded Pedestals for Transmission Line Supports (Autogen geschweisste Konsolen zu Leitungstragern) *Zeitschrift für Schweisstechnik,* Vol. 23, Oct. 1933, page 261. Brief description of welded T-iron pedestals, and photographs showing results of tests of the fusion weld. RRS (7b)

Electric Arc Welding in Ship Construction. *Sheet Metal Industries,* Vol. 7, Aug. 1933, pages 249-251. New rules laid down by the British Corporation Register of Shipping and Aircraft. AWM (7b)

Applications of Fusion Welding (Applications de la Soudure autogène) *Usine,* Vol. 42, Nov. 16, 1933, page 30. Discussion of welding in repair and maintenance work with examples of repairs on cylinders, wheels, thin sheets, etc. Ha (7b)

Oxy-Acetylene Cutting. *Welding Engineer,* Vol. 18, Mar. 1933, pages 26-27. Describes the cutting of the risers in Cr-Ni castings; the blowpipe must be used in such manner that the preheating flame is not oxidizing when the cutting jet is wide open. Ha (7b)

Repair of a Stern Frame by Thermit Welding. *Welder,* Vol. 5, Oct. 1933, pages 7-14. The thermit welding process is briefly explained; a gap of 22" length and 1 3/8" wide was repaired successfully. Ha (7b)

Welding Problems. *Shipbuilding & Shipping Record,* Vol. 41, May 11, 1933, pages 460-461. Problems discussed are the effect of welding on shipyard practice with particular reference to the preparation of the work so far as the general reorganization of existing practice is concerned, the relative advantages of oxy-acetylene and electric-arc welding, and the various types of joints to be dealt with. Consideration is also given to the application of welding to ship construction in the production of an all-welded ship and to the combined influence of riveting and welding. JWD (7b)

Repairing a Cracked Stern Frame. *Shipbuilding & Shipping Record,* Vol. 42, July 13, 1933, pages 36-37. A detailed description illustrated by photographs of the repair by the use of the Thermit process of the cracked stern frame of the British steamship "Lafian." JWD (7b)

Scientific Foundations of Fusion Welding (Les Bases Scientifiques de la Soudure Autogène) A. PORTEVIN. *L'Usine*, Vol. 42, May 12, 1933, pages 25-27. Chemical, physico-chemical and metallurgical aspects of fusion welding are discussed in their bearing on producing a satisfactory weld. Only by specifying the initial condition of the pieces to be welded, subsequent treatment, welding procedure, flux and gas and ultimate use can it be determined if welding is a suitable process to be applied in the case. Ha (7b)

Welding of Rods in Iron-Concrete Construction (Rundeisenschweissung in Eisenbetonbau) F. H. PROBST. *Der Bauingenieur*, Vol. 14, July 21, 1933, pages 290-292. Tensile strength, bending strength and processing of various types of fusion welded rod joints were investigated and valuated. GN (7b)

Welded Steam Pipes on Gasworks Power Plants. *Gas Engineer*, Vol. 58, Sept. 1933, pages 473-474. Advantages and short-comings of screwed, flanged and welded joints are considered with special reference to power plant piping. Some typical joining possibilities are shown in 12 illustrations. The patented Sargol and Sarlun joint are stressed. WH (7b)

Is Gas Cutting an Art? (L'Oxy-Coupage Est-il un Art?) *Revue de la Soudure Autogene*, Vol. 25, July 1933, pages 2826-2827. Works performed by a jobbing shop in the north of France are described. The workers are able to hand cut, i.e., without the help of gas cutting machines, with extraordinary accuracy, pieces for engineering industry as well as for artistic works. Illustrations are given which clearly prove the fact. FR (7b)

Welding as Applied to Metallic Ties for Supporting Railways (L'Utilisation des Traverses Métalliques sur les Voies Ferrées) *Revue de la Soudure Autogene*, Vol. 25, July 1933, page 2828. Abstract from "Ossature Métallique." Various methods applied to fasten rails on metallic sleepers are examined. Processes adopted by the Belgian firms : "Société Ougrée et Marihaye" and "Angleur-Athus" for fixing the rails are described and illustrated. Both processes resort partially to welding. FR (7b)

Application of Fusion Welding in Different Countries (L'application de la Soudure Autogène dans les Différents Pays) *Revue de la Soudure Autogene*, Vol. 24, Nov. 1933, pages 2642-2643. Examples given with illustrations are the following (1) band saw frame entirely welded fabricated by Dewalt Product Co. of Lancaster. (2) "Mythen" a passenger boat for 200 persons and travelling at 28 km./hr. on the Luzern Lake in Switzerland. (3) Automatic machine for oxy-acetylene welding of pipe lines (America). (4) Rescue chamber for crews of foundered submarine boats (America). FR (7b)

Welding Processes Benefit from Research Studies. *Steel*, Vol. 92, Jan. 2, 1933, pages 90-91, 100. Review of developments in welding during 1932, with brief consideration of riveted construction. MS (7b)

12-Ton Roll-Changing Hook Provides Severe Test of Weld Strength. *Steel*, Vol. 92, Jan. 9, 1933, pages 19-20. At the Riverside Works of the Otis Steel Co., Cleveland, a hook constructed of arc-welded steel plates is used to lift rolls weighing up to 60 tons. MS (7b)

Wrought Iron Bridge 45 Years Old Rehabilitated by Steel and Welding. *Steel*, Vol. 92, Feb. 13, 1933, page 20. Bridge in Chester County, Pa., is being reconstructed and strengthened by arc welding. MS (7b)

Effect of Slag Inclusions on Weld Quality Made by Electric Resistance Welding (De invloed van slakinsluitingen op de kwaliteit van een laschnaad bij electrisch weerstandslaschen) *Polytechnisch Weekblad*, Vol. 27, July 6, 1933, pages 421-422. In 13 microstructures, the occurrence of unsound welds is linked to slag inclusions in the parent metal. Utilitization of automatic, adequately large welding units is urged which results in a reduction of the welding time. Shorter melting times partly eliminate the harmful effect of slag inclusions. WH (7b)

Structural Work Built-up of Welded Tubes (Gelaschte buisconstructie) *Polytechnisch Weekblad*, Vol. 27, Oct. 19, 1933, pages 674-675. Attention is called to the amazing possibilities which welded tubes offer to structural engineering. Objections rejected refer to danger from inside rusting, more expensive preparation of tube ends, and higher initial costs. According to German conditions, a saving in weight amounting to 56% would justify the utilization of tubes as construction material. Savings of 30-40% are actually accomplished so far. Advantages claimed besides lower weight are reduced resistance to wind, smaller surface to be painted and maintained, easy dripping off of rain, water, etc., reduced shadow effects, and possibility of using the tubes incorporated in a structure for conduction purposes. WH (7b)

Engineering the Design of Welded Products. *Product Engineering*, Vol. 4, Mar. 1933, pages 82-99. A symposium in which several authors treat the application of welding in industry. Greatest stress is laid on necessity of applying engineering fundamentals not only to the structure as a whole but also to the component parts and their materials. The various fields discussed are: rolled steel for the welded product, flame-cutting and gas welding, designing for automatic welding, specifications for welded products, designing as a 4 dimension problem, vibrations of structures and materials, constant strength structures, machine tools built of rolled steel. Ha (7b)

Hard-Facing Reduces Die Costs. *Machinery*, (N. Y.) Vol. 39, June 1933, pages 630-632. Hard-facing alloy in the form of Haynes-Stellite rods, 5/16" in diameter, was applied to all cutting edges by oxy-acetylene welding. Describes process and gives costs of this process in hard-facing dies used in the production of steel drums for calcium carbide. RHP (7b)

Electrically Welded Tanker (Een geheel electrisch gelascht tankschip) *Polytechnisch Weekblad*, Vol. 27, June 15, 1933, pages 377-378. Gives full structural details on a 54 m. long fuel supply ship assembled by electric welding in the Sun Shipbuilding & Drydock Co.'s shipyards at Chester, Pa. WH (7b)

Producing Strong Joints by Hydrogen Welding. *Machinery*, (N. Y.), Vol. 39, Aug. 1933, pages 778-780. Discusses the process in which welding is done in a furnace having a reducing atmosphere. Cu is added to the joint and in the reducing atmosphere penetrates the iron giving a good joint. The furnace atmosphere is known as "Electrolene" and is made by treating city gas with steam at 2,000°F. Average analysis of "Electrolene" is: H_2 58.4%, CO 30%, CO_2 1.2%, O_2 1.2%, CH_4 1.7%, and N 7.6%. Describes and illustrates several applications. RHP (7b)

Improved Cutting-off Equipment for the Up-to-Date Shop. *Machinery*, (N. Y.), Vol. 39, Jan. 1933, pages 329-330. Describes and illustrates a few of the newer metal cutting machines; gives applications. RHP (7b)

Electric Welding Has Rapidly Gained Ground in Industry. *Machinery*, (N. Y.), Vol. 39, Jan. 1933, pages 323-328. Discusses and illustrates new methods and equipment used in welding. Gives general details of a few industrial operations. RHP (7b)

Advances Made in the Field of Gas Welding and Cutting. *Machinery*, (N. Y.), Vol. 39, Feb. 1933, pages 386-387. General discussion of recent advances. Illustrations show a few applications. RHP (7b)

Welded Steel Construction. *Machinery*, London, Vol. 42, July 27, 1933, pages 485-490. Welded steel constructions produced by the Metropolitan-Vickers Electrical Co., Ltd., and welding equipment and electrodes developed by this company are discussed. Tables giving comparisons of parts made of cast iron and fabricated steel show savings in weight and cost. Welding operations with automatic seam welding machines are discussed. Automatic atomic hydrogen seam welding machine and ammonia cracking plant are described. Kz (7b)

Shot Welding. *Machinery*, London, Vol. 42, Aug. 3, 1933, pages 521-522. Shot welding is a process of spot welding in which the period of current application is reduced to a minimum and is little more than required to cause complete fusion of the metal at its surface of contact. It was developed in order to overcome difficulties experienced in welding austenitic steels, which, if heated to within 500°-900° C., suffer a serious reduction in corrosion resistance. The shot welding process proved satisfactory in welding these as well as other stainless steels. Discussion of the shot welder and tests. Kz (7b)

Successful Bronze Welding Pays Dividends. *Industry & Welding*, Vol. 6, Aug. 1933, pages 8-10. A few cases are described of welding broken cast iron parts with bronze rods instead of cast iron rods. This method is said to be quicker, does not require any machining and gave entirely satisfactory results. Ha (7b)

How to Make Machinable Cast Iron Welds. *Foundry Trade Journal*, Vol. 49, Aug. 10, 1933, page 83. Article illustrated by 2 photographs of the body of a large press which had been welded with Monel metal electrodes. Such electrodes give, subsequent to welding, a surface as readily machinable as the parent metal. OWE (7b)

Welding in the Steel Industry—Rational Design as Applied to Mill Housings. WILLIAM H. WARREN. *Iron Age*, Vol. 131, Mar. 23, 1933, pages 464-465, adv. sec. pages 10, 12. First of five articles submitted for the second are welding prize sponsored by Lincoln Electric Co. Photoelastic studies of stress distribution in mill housing reveal local stresses that may be as high as 6 times the average stress. Adding metal to outside contour has not cured the breakage. Eliminating local weaknesses the life of housing is increased and weight considerably reduced. With service life of from 8 to 10 yrs., welded steel housing developed from these studies is a source of definite economies. VSP (7b)

American Naval Practice. *Journal of Commerce (Shipbuilding & Engineering Edition)*, July 6, 1933, pages 1 and 2. Electrically-welded boiler drums, each drum weighing only 10,000 lbs. as against 13,000 lbs. for a riveted drum, have been supplied to the United States Navy. The material used, the method of manufacture and actual tests carried out on a welded drum are given, and the special significance of such tests are discussed. JWD (7b)

The Use of Arc Welding. *Journal of Commerce (Shipbuilding & Engineering Edition)*, June 8, 1933, page 3. The uses of arc welding in the repair of ships are discussed, together with the methods of testing welded work, classification requirements for testing electrodes, the types of electrodes used for different classes of work, and the physical qualities of welds. JWD (7b)

Discusses Objections to Use of Welded Steel Floors. *Iron Age*, Vol. 131, Mar. 9, 1933, pages 387-388, adv. sec., page 12. Deals with some of the most common objections to the use of welded steel floors, such as: They may be too noisy; pipes, conduits, etc., may be difficult to install; fear that expansion and contraction due to temperature may lead to serious results; high cost; welding unreliable, etc. Shows that some of the objections to steel plate floors are not valid and others can be greatly reduced by proper study of factors involved. VSP (7b)

Flash Welding Automobile Doors. *Iron Age*, Vol. 131, Feb. 23, 1933, pages 316-317. Describes methods of flash welding and other features in production of automobile doors at the plant of Edward G. Budd Manufacturing Co., Philadelphia. VSP (7b)

Determination of the Oxygen and Nitrogen Absorption in Fusion Welds (Auswirkungen der Sauerstoff—und Stickstoffaufnahme bei Schmelzschweissen.) E. PIWOWARSKY & W. KLEINEFENN. *Archiv für das Eisenhüttenwesen*, Vol. 7, Sept. 1933, pages 205-208. Oxy-acetylene and electric arc welds were made using 0.02 to 0.1% C plain carbon and also 3.5% Ni electrodes, bare and coated. Bare electrodes in electric arc welding gave the highest N_2 and O_2 absorption. In gas welding with bare welding rods less N_2 and O_2 were absorbed than in electric arc welding with coated electrodes. Alternating current favored the absorption of N_2 and O_2 as against direct current; Ni and Mn hindered N_2 and O_2 absorption. O_2 and N_2 caused an increase in hardness and strength of the welded metal, but a lowering in ductility and impact resistance, particularly after aging. SE (7b)

Classification and Electric Welding (Klassifizierung und Elektroschweissung) R. SCHMIDT. *Werft, Reederei und Hafenbau*, Vol. 14, Aug. 15, 1933, pages 222-226; Sept. 1, 1933, pages 238-242; discussion: SCHMUCKLER, Dec. 1, 1933, pages 336-337; R. SCHMIDT, Dec. 1, 1933, pages 338-339. A critical comparison between the specifications in the fields of electric welding for ship-building as set forth by British, French, Norwegian, Italian, American and German organizations. The author goes into very great detail in regard to butt welding, inspections of welds, bare vs. coated electrodes, a.c. vs. d.c., current intensity, tensile testing of samples, hardness, bending, vibration, impact, fatigue testing and aging of welds. Besides the different standard regulations mentioned above, 14 fundamental publications are cited and data on 4 physical properties and analysis (C, Mn, Si, N) of a welding material deposited by 7 different methods are presented. Schmuckler points out the proper form of butt, strap and overlap welding and enlarges on shrinkage testing and the new testing machines of the A.E.G. (magnetic) and of his own (milling apparatus). Mentions that the endurance strength of dynamically stressed constructions could be raised 60% due to partly milling of the welds. This is ascribed to improvement of the stress flow and the elimination of minute notches. WH (7b)

Repair Crossings by Welding. A. W. SHELDON. *The Railway Engineer*, July 1933, pages 217-218. Paper before the Permanent Way Institution, London, April 1933, discusses in detail the practice of the Southern Railway of reconditioning worn crossings by electric arc welding. Average time is 2.7 hrs. and 1.85 hrs. for shaping up or 68% of the welding time. The deposition of weld metal on sound and clean parent metal is stressed. The desirability of maintaining all crossings, welded or otherwise, cannot be too strongly emphasized. The portable welding plant includes (1) a petrol engine of 15 HP. rating, directly coupled to (2) a dynamo of 6 k-w capacity and both are mounted on (3) a frame, from which each can be detached separately for transportation purposes. The apparatus for grinding the deposited metal smooth and to correct gage and profile consists of a portable 2.5 HP. 50 volt electric motor which drives through a flexible shaft about 7 ft. 6 in. long and 8 in. diameter a 1¼ in. wide grinding wheel at 3000 r.p.m. WH (7b)

Critical Discussion on Welding of the German Standard Steel St. 52 (Kritische Betrachtung über das Schweissen der Stähle St. 52) PASSAU & ROSENTHAL. *Polytechnisch Weekblad*, Vol. 27, Oct. 19, 1933, pages 661-668. (In German.) Paper before the Dutch Vereeinging voor Laschtechniek, Rotterdam, 1933. Multiple-bead welding does not impair the parent metal in the transitional region of the medium alloyed German structural steels "St. 52," but rather results in an improvement of the micro-structure of the zone affected. The physical properties of the electrode material are closely approaching those of the steels themselves, without being identical with the latter in chemical regard. When only a single layer of deposited metal is employed, a "super-heated micro-structure" in the virgin metal occurs. This structure is more sensitive towards dynamic stresses. Tables and diagrams are included showing testing results gained on welds joining steels of different German manufacturers, but all of the standard type St. 52 (tensile strength = 52 kg./mm.^{2}). By means of the Fe-C constitutional diagram and microstructures, the structural changes in the transitional regions between virgin metal and deposited weld material are thoroughly discussed. WH (7b)

Use of Gas Welding in the Manufacture of a Gear and a Pulley (Anwendung der Gasschmelzschweissung bei der Herstellung eines Zahnrades und einer Riemenscheibe) H. EBERSBERGER. *Autogene Metallbearbeitung*, Vol. 26, Aug. 15, 1933, pages 242-245; *Forschungsarbeiten auf dem Gebiete des Schweissens und Schneidens mittels Sauerstoff und Azetylen*, Series 8, 1933, pages 51-54. Detailed description of procedure and cost of production. Ha (7b)

Constructing an all-Welded Hoist. W. H. DELLINGER. *Electric Welding*, Vol. 6, Oct. 1933, pages 28-30. Describes manufacture of an all-welded 125 H.P. double-drum mine hoist. Ha (7b)

Arc Welding in Hoist Design. GEO. M. DICK. *Industry & Welding*, Vol. 6, Aug. 1933, pages 11-14, 27-30. The use of welded steel parts in hoisting machinery is outlined. Time in machining, weight and material is saved to a great extent over cast parts; labor cost was only 63% in the case of a welded steel drum barrel against a cast-steel barrel. Due to lighter weight power requirements for acceleration are lower. Ha (7b)

New Successes of Electrical Welding (Neue Erkenntnisse und Erfolge bei der elektrischen Schweissung) PROX. *Werkstoffe und Korrosion,* Vol. 8, Nov. 25, 1933, pages 42-44. The special welding process of Pintsch is described which was developed to make electric arc-welding applicable for structures which required, besides high strength, elongation, toughness, strength at elevated temperatures and resistance to aging not only of the material but also of the welded joints. This was achieved by using electrodes similar to the material to be welded and which were thickly covered (not said by what). The process gives joints of a quality which the standards for steam boilers rate at 0.9 of the material. After welding internal stresses are relieved. The values obtained for welds of boiler plates of 35-44 kg./mm.^{2} tensile strength (I) and of 41-50 (II) were:

		I	II
Tensile strength, kg./mm.^{2}		38.3	48
Elongation for 20-40 mm.	%	25	30
Reduction of area	%	25	28
Bending angle	°	180	180
Bending elongation, outer fibre	%	30	31
Notch-toughness, mkg./cm.^{2}		18.1	18.8

Ha (7b)

Fusion Welding in France in 1932 (La Soudure Autogène en France en 1932) *Revue de la Soudure Autogène,* Vol. 24, Dec. 1932, pages 2654-2656. It is shown that welding, owing to its newness, has suffered less from depression than other industries. Developments noted during the year are reviewed. Studies are being made to determine type of joints most suitable for each kind of work and, when welding must be resorted to, best type of process to be chosen. General studies on weldability of metals and alloys have been undertaken in 1932. Education for welding technique has been thoroughly developed but has not been fully applied. Numerous new books have been published spreading knowledge of welding processes. All organizations such as welding schools, Welders' Associations, and bureau of information work in close cooperation. Oxy-acetylene welding has progressed but not equipments used. Arc welding has shown considerable development but unfortunately, method is sometimes applied in cases when it is not economical. Equipment for this process is continuously improved; coated electrode is more and more used. For resistance welding, improvements are noted only in equipments but are numerous. Hard bronze welding has shown the most important development in its uses. Finally it is concluded that gas cutting, although in progress, is not always used to best advantage in a great number of shops. FR (7b)

Riveting and Welding of Structural Steels with Emphasis on High-grade Qualities (Über das Nieten und Schweissen der Baustähle, insbesondere der hochwertigen Baustähle) K. SCHÖNROCK. *Polytechnisch Weekblad,* Vol. 27, July 13, 1933, pages 433-438. (In German.) Lecture before the Vereeniging voor Laschtechniek, Amsterdam, May 13, 1933. Table giving analysis and physicals of 10 most important German brands of structural steels. The evolution from wrought iron to the standard steel St. 52 (minimum tensile strength = 52 kg./mm.^{2}) is historically traced. The speaker discusses at length why the present problems of structural welding and riveting are now a challenge to the designer rather than to the metallurgist. Hand riveting gave better seams than machine riveting. Increasing the strength of rivets should not be performed by raising the C content but by employing alloy elements. Si bearing rivets exhibited heavy scaling. In rivets submitted to reversed stresses, a favorable resistance to gliding is more important than high tensile strength. Experimental data are presented. Difficulties due to transformations in the regions adjacent to welds were encountered in the beginning on account of higher Mn, Si, Cr, Mo, and Cu contents in the latest high-grade structural steels (Microstructures). 4 tables are presented showing the physicals of St. 52 welded by different kinds of electrodes (no composition given). The alarming reports on endurance failure of welds are rejected and attention is focused on local over-stressing due to faulty design. The failure of a butt weld due to dynamic stress is interpreted at the point of the stress distribution, the computation of which is a task of the designer. Data and proper design are given. WH (7b)

Critical Considerations on the Testing Methods of Weld Joints (Kritik an Prüfverfahren für Schweissverbindungen) A. MATTING & C. STIELER. *Stahlbau,* Vol. 6, Nov. 24, 1933, pages 185-187. The high loads to which weld seams are subjected both statically and dynamically could be permitted merely by the possibility of making better seams and testing them. The paper particularly deals with the various methods developed for detecting defects in weld seams, as X-raying or the electromagnetic- accoustic testing method according to Schweizer-Kiesskalt. The latter new method seems to be rich in prospects though sufficient practical experiences are not known yet to pass final judgment. These methods may be supplemented by the Schmuckler method in which the seam is superficially milled. In order to determine in how far coarse structural defects in seams can be detected by X-raying and the Schmukler method respectively comparative tests were carried on by the Experimental Welding Station of the German Railway at Wittenberge. Welds were intentionally provided with defects and then tested by X-rays, the Schmukler method and also mechanically and microscopically. GN (7b)

Scaffolding by Welding and Cutting (Behelfsbauten durch Schweissen und Schneiden) J. C. FRITZ. *Autogene Metallbearbeitung,* Vol. 26, Sept. 1, 1933, pages 259-262. Several examples show that scaffolding and temporary buildings or structures can often be made economically of welded steel parts instead of wood, in spite of higher prices of the former. Ha (7b)

New Methods in Machinery Repair C. W. BRETT. *Glass,* Vol. 10, Nov. 1933, pages 462-463. Means for effecting great economies in repair of machinery in glass plants by welding is discussed and examples are shown. Ha (7b)

Tendencies and Novelties in Fusion Welding (Tendences et Nouveautés en Soudures Autogène) R. GRANJON. *L'Usine,* Vol. 42, Apr. 14, 1933, page 31. The various methods of welding by electric arc and flame as at present applied in France are discussed. Flame cutting is the least developed. Ha (7b)

Welding in Steel Construction (Schweissen im Stahlbau) E. GREGER. *Forschungsarbeiten auf dem Gebiete des Schweissens und Schneidens mittels Sauerstoff und Azetylen,* Series 8, 1933, pages 47-51; *Autogene Metallbearbeitung,* Vol. 26, Mar. 1, 1933, pages 65-69. A few recent examples of welded structures, columns for large halls, trusses, boiler foundations, etc. are illustrated and the savings which have been obtained by fusion-welding over riveting both in weight and time are pointed out. Ha (7b)

Welding Heavy Mechanical Equipment. A. E. GIBSON. *Industry & Welding,* Vol. 5, Mar. 1933, pages 2-6. Describes construction and welding procedure of a large mooring mast for airships. Ha (7b)

Electrically Welded Railroad Stations of the Suburban Railroads at Berlin (Die electrisch geschweissten Bahnhofshallen der Wannseebahn Berlin) OTTO BONDY. *Elektrowärme,* Vol. 3, July 15, 1933, pages 225-227. Many examples are described of welded platform roofs, halls, crossings, etc. Ha (7b)

Designing Welded Steel Machine Bases. T. JOHNSTON. *Electric Welding,* Vol. 3, Nov. 1933, pages 3-6. Examples of lathes, machine tools, etc. are illustrated. Ha (7b)

Welding of Chains with the Oxy-Acetylene Flame (Kettenschweissung mit der Azetylen-Sauerstoff-Flamme) F. HERMANN. *Autogene Metallbearbeitung,* Vol. 26, Oct. 15, 1933, pages 311-312. Describes procedure; worn places are built up. Ha (7b)

Repair by Welding of Water Coolers in Zinc Smelters (Ausbesserungsschweissung an Wasserkühlern im Zinkhüttenbetrieb) W. HOENISCH. *Autogene Metallbearbeitung,* Vol. 26, Nov. 1, 1933, pages 328-329. Describes procedure with 2-flame burner. Ha (7b)

Repair of a Cast-Iron Slag Ladle by Acetylene Welding (Instandsetzung einer gusseisernen Schlackenwanne durch Azetylenschweissung) W. HOENISCH. *Autogene Metallbearbeitung,* Vol. 26, Oct. 15, 1933, page 312. Describes procedure. Ha (7b)

Welding of Maritime Signals by Oxy-Acetylene Flame (Schweissung von Seezeichen mit der Azetylen-Sauerstoff-Flamme) W. HOENISCH. *Autogene Metallbearbeitung,* Vol. 26, Nov. 1, 1933, pages 325-326. Describes manufacture of buoys. Ha (7b)

Fusion Welding of Office Furniture from Thin Sheets (Autogenschweissung eines Büroschrankes aus dünnen Blechen) W. HOENISCH. *Autogene Metallbearbeitung,* Vol. 26, Oct. 15, 1933, pages 317-318. Describes welded construction of a filing cabinet. Ha (7b)

Power-Plant Type Welding. J. A. BLECKI & F. J. SCHLACHTER. *Welding Engineer,* Vol. 18, May 1933, pages 20-23. Methods and equipment used by the Detroit Edison Company for welding of piping are described and illustrated. Ha (7b)

Welding and Laying an Under-Sea Pipeline. W. E. ARCHER. *Welding Engineer,* Vol. 18, Nov. 1933, pages 20-21. 2 lines of 16″ and 8″ resp. and 1 mile long each were laid in 50 ft. water for loading and unloading tankers with liquid fuels. Welding procedure and methods of laying out the line are described. Ha (7b)

Maintenance of Valves and Mechanical Parts. R. BRISCOE. *Welding Engineer,* Vol. 18, July 1933, pages 13-14. Welding is used in maintenance and repair of parts of power plant equipment subject to heavy wear. Examples are illustrated. Ha (7b)

Welding of a 6,000,000 Gallon Water Storage Tank. H. H. BROWN. *Water Works & Sewerage,* Vol. 53, July 1933, pages 237-240. Describes in detail erection of an all-welded tank of 165 ft. dia. and 37 ft. 6 in. high. It is sandblasted and received 3 coats of paint: first of chromate of lead, another two coats of chromate of lead on the inside and two coats of Al paint for the outside. The total weight is about 660 tons. Ha (7b)

Welds and Stresses. H. N. BOETCHER. *Welding Engineer,* Vol. 18, Sept. 1933, pages 15-18. Relationship between stresses in and properties of a material and the creation of stresses by welding are discussed. The means of preventing occurrence and distributing local stresses are explained and the conditions producing stress concentrations described; at such places the local stress might exceed the fatigue limit causing cracking and the creation of fissures. Ha (7b)

Shrinking Stresses in Electric Butt-Welds (Schrumpfspannungen bei elektrisch geschweissten Stumpfnähten) H. GEHRING. *Mitteilungen aus dem Forschungsinstitut der Vereinigte Stahlwerke A. G. Dortmund,* Vol. 3, May 1933, pages 107-128. The internal stresses which are created by the heating and cooling of the material in the neighborhood of and by the solidification of the weld itself are discussed and the methods, experimental or theoretical, for their determination reviewed. A new method is developed which permits the measurement of elongations of 1/5000 mm. The tests with different steels and bare and covered electrodes always showed greater values of shrinkage and tension for the covered electrodes which is ascribed to increased heat consumption, greater depth of the weld and consequently greater mass of the melt. Continuous welds show the greater stresses, the "Pilger" step (pilgrim's step) with one-layer seam is the most favorable; but not more in multiple-layer seams. Smaller electrode diameter reduces the stresses, independent of the material. When cooling a welded joint, care should be exercised to cool weld and material equally as otherwise increased stresses take place. 13 references. Ha (7b)

How can Power Plants Promote Electric Welding? (Wie können die Elektrizitätswerke die weitere Verbreitung der Elektroschweissung fördern?) FR. MÖRTZSCH. *Elektrizitätswirtschaft,* Vol. 32, Aug. 25, 1933, pages 358-361. See *Metals & Alloys,* Vol. 4, June 1933, page MA 182. EF (7b)

Oxy-Acetylene Welded 2000 kg. Crane. (Autogen geschweisster Kran für 2,000 kg.) F. NEDVEDICKY. *Zeitschrift für Schweisstechnik,* Vol. 23, Sept. 1933, pages 241-242. The crane bridge, consisting of a 3800 mm. I-beam was mounted on the rails by means of U-shaped end pieces. The assembling was performed by oxyacetylene welding. A table gives the time required and the gas consumption for the various welding operations. RRS (7b)

Deflection Phenomena in Welding of Cast Iron for Machine Tools (I Fenomeni di Incurvamento nella Fusione dei Getti di Ghisa per Macchine Utensili) R. MARKER & E. LONGDEN. *L'Industria Meccanica,* Vol. 15, Jan. 1933, pages 16-19; Feb. 1933, pages 115-116. The forces developing in a casting of T-shape (for instance bed plates or foundations) are mathematically analyzed and tables and nomograms developed to calculate the resulting deflections from the dimensions of the casting. Ha (7b)

Present State of Electric Welding (Gegenwärtiger Stand der Elektroschweissung) KARL MELLER. *Elektrotechnische Zeitschrift,* Vol. 54, July 6, 1933, pages 656-659. Present methods of arc and resistance welding are reviewed, welding generators for d.c. and a.c. and auxiliary equipment described. Ha (7b)

Increase of Velocity in Flame Cutting (Geschwindigkeitssteigerung beim Brennschneiden) H. MALZ. *Zeitschrift Verein deutscher Ingenieure,* Vol. 77, Apr. 8, 1933, pages 380-381. The relations between cutting speed, advance of burner, oxygen pressure and nature of material were exhaustively investigated; limiting speed is defined as that speed beyond which no increase of pressure can eliminate the grooves formed by the flowing material on the edges of the cut. The limiting speed was found to be 180 mm./min. for a steel sheet thickness of 10 mm., a nozzle of 0.5 mm. opening and an 0 pressure of 12.25 atmospheres; for a nozzle diameter of 2.95 a limiting speed of 480 mm./min. was obtained at only 2 atmospheres pressure. A table was developed for the most economical nozzle diameter which in connection with the limiting speeds can be used for cost calculations. Ha (7b)

Recent Progress in Oxy-Acetylene Welding and Cutting Processes. D. S. LLOYD. *Engineering Journal,* Vol. 16, July 1933, pages 307-309. Some recent developments in oxy-acetylene welding are the use of a carbonizing flame and new type of welding rod to effect an increase in the speed of welding, the use of automatic oxy-acetylene cutting machines with machine-controlled blow pipes to increase the speed and produce smooth cuts, and the use of flame machining, in which the blow pipe is held almost tangential to the surface of the metal. VVK (7b)

Welding Pipes 30 Feet in Diameter. C. B. LORD. *American Machinist,* Vol. 77, Dec. 20, 1933, pages 805-808. Process of welding and stress relieving of pipes for Boulder Dam is described. Ha (7b)

The Effect of Flame-Cutting on Steel. *Oxy-Acetylene Tips,* Vol. 12, Nov. 1933, pages 249-250. A review of recent investigations. Oxy-acetylene cutting is entirely satisfactory for low carbon steel. Most high C and alloy steels can be flame-cut when the material is preheated and slowly cooled. Appearance required, smoothness, etc., will determine whether hand or machine cutting is to be applied. Ha (7b)

Scrap Box—Not Scrap Pile. *Oxy-Acetylene Tips,* Vol. 12, July 1933, pages 155-156. The advantages of bronze welding for repairing cast iron parts and steel castings are pointed out by the example of the maintenance work for a fleet of trucks and buses where cracked engine cylinders were repaired in this manner. Ha (7b)

Cooling—An Essential Factor. *Oxy-Acetylene Tips,* Vol. 12, July 1933, page 157. Cracks of 18″ length in a cast iron dryer head of 4½ ft. diameter were successfully welded with bronze with preheating and careful cooling. Ha (7b)

Welding of Boilers, Pressure Tanks and Pipe Lines (Schweissung an Dampfkesseln, Druckbehältern und Rohrleitungen) E. Block. *Glückauf*, Vol. 69, July 22, 1933, pages 651-658. German rules and regulations for welding are discussed and examples of good and bad welds illustrated. A table for the rating of quality of different welding methods is given which shows what percentages of tensile stress of the solid (unwelded) material are at present admissible according to the rating of a welding method with respect to safety. Destructive and non-destructive tests are described. Ha (7b)

Fusion Welded Rail Joint (Der autogen geschweisste Schienenstoss) W. Johag. *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 23, Sept. 17, 1933, pages 500-501. Describes a number of methods for joining rails by welding. Experience shows that normal butt welding of joints is best method. The procedure is outlined. GN (7b)

Practical Oxwelding in the Lumber Industry. *Oxy-Acetylene Tips*, Vol. 12, Oct. 1933, pages 221-226. Diversified applications in logging and lumbering operations, in particular in repair and maintenance, are described and illustrated. Ha (7b)

Stipulations for Delivery and Acceptance of Accessory Materials for Gas- and Arc-Welding of Steel (Bedingungen für die Lieferung und Abnahme von Zusatswerkstoffen für die Gas- und Lichtbogenschweissung von Stahl) *Autogene Metallbearbeitung*, Vol. 26, Aug. 15, 1933, pages 249-252. The German Code for quality, dimensions of welding rods, behavior, chemical composition, testing and preparation of specimens is reprinted. Ha (7b)

Why Monel Metal Produces Soft Welds in Cast Iron. *Electric Welding*, Vol. 3, Nov. 1933, pages 10-11. In order to avoid the extremely hard welds in cast iron which are produced if it is not preheated and an electrode of soft steel is used, the use of Monel metal electrodes is recommended. No cementite and carbide is then formed due to the high percentage of Ni (68%). Not more than 2" should be welded at a time and in a cold casting (not preheated); the short weld is then hammered gently to reduce the strains resulting from cooling and to increase density of the weld. After the weld has cooled completely the next weld can be started. Ha (7b)

Welding Drills to Shanks and Then Heat-Treating. *Electric Welding*, Vol. 6, Oct. 1933, pages 26-27. The joining of high-speed steel drills to carbon steel shanks (0.7% C) is described. Ha (7b)

New Process for Arc-welding Copper. *Electric Welding*, Vol. 6, Oct. 1933, pages 34-35. Welds of Cu with 100% strength and capable of being bent 180° were made with a long carbon or graphite arc; a gaseous atmosphere is produced by the long are protecting arc and molten metal from oxidation which is the cause of weakness in Cu welds. From 12" to 24" can be welded per min. according to the thickness of the material. Ha (7b)

Steel-frame Motor Manufacture; the Norwich Works of Laurence, Scott and Electromotors, Ltd. *Electrical Review*, Vol. 113, Sept. 1, 1933, page 283. Arc welding is used extensively. MS (7b)

Welded-steel Construction of Motors; the L. S. E. System for A.C. Machines. *Electrical Review*, Vol. 113, Oct. 6, 1933, page 458. Brief description of method used by Laurence, Scott & Electromotors, Ltd. MS (7b)

Electric Welding Suitable for Everdur. *Electrical World*, Vol. 102, Dec. 16, 1933, page 786. Discussion on the welding by metallic-arc, carbon-arc, or resistance-seam methods of Everdur "A," the 96% Cu alloy used in hot water tanks, etc. CBJ (7b)

Uniform Spot Welding with Automatic Timers. *Electrical World*, Vol. 102, Nov. 25, 1933, page 700. Circuit and apparatus described for securing automatic timing in spot welding. Automatic timing produces uniform welds, reduces the rejects, controls speed of welding, and eliminates inspections. CBJ (7b)

Choice of Current Type in Welding (Die Wahl der Stromart beim Schweissen) *Die Elektroschweissung*, Vol. 4, Dec. 1933, pages 238-239. Abstract of a paper by U. Naimuschin in *Avtogennoje Delo*, 1933, No. 4. In order to study the effect of welding current type on properties of welds, tensile strength, plasticity, hardness and toughness of more than 500 welded samples were tested and examined by X-rays, microscopic and magnetic tests. Test samples were made of soft steel with non-coated and coated electrodes, butt welded in horizontal and vertical direction with d.c. of 130-170 amperes and a.c. of 136-178 amperes. Principal results: (1) Tensile strength: d.c. welding with non-coated electrodes gives no satisfactory results. D.c. welding with coated electrodes gives tensile strengths around 30 kg/mm.^{2} Vertical welding is better than horizontal. Horizontal a.c. welding with coated electrodes gives a tensile strength around 34 kg/mm.^{2} Also in this case vertical welding is better than horizontal. (2) For alike amperage d.c. shows deeper burning-in than a.c. welding. (3) Impact toughness is low for all current types. (4) Bending strength fluctuated considerably. (5) Hardness of weld is always higher than that of base metal. GN (7b)

Electric Welding in the Electric Heat Exhibition at Essen (Die Elektroschweissung auf der Elektrowärme- Ausstellung Essen) *Die Elektroschweissung*, Vol. 4, Sept. 1933, pages 172-175. Illustrated description of exhibition with particular reference to the application of electric welding in many branches of industry. GN (7b)

Standards of the "Registro Italiano Navale ed Aeronautico" for the Application of Electric Arc Welding in Building and Repairing Ships (Normen des "Registro Italiano Navale ed Aeronautico" für die Anwendung der elektrischen Lichtbogenschweissung beim Bau und bei Reparaturen von Schiffen) *Die Elektroschweissung*, Vol. 4, Nov. 1933, pages 209-214. Detailed outline of the standards (1) general, (2) equipment and type of electrodes, (3) welding and safety rules, (4) drawing, (5) butt welding, (6) lap welding, (7) point welding, (8) welding flank seams, (9) testing of electrodes, (10) mechanical tests of welds, (11) general rules on constructions, (12) supervision of construction. GN (7b)

Electric Welding of Davits (Elektroschweissung bei der Herstellung von Boots-Aussetz- Vorrichtungen) *Die Elektroschweissung*, Vol. 4, Nov. 1933, page 219. Description of electrically welded davits made of Fe plates. GN (7b)

L. N. E. R. Welded Wagon Underframes. *Engineer*, Vol. 155, June 16, 1933, page 600. Gives particulars of an experimental wagon in the framework of which electric arc welding has been used instead of the usual riveted joints. LFM (7b)

Electric Arc-Welding in Ships. *Engineering*, Vol. 136, July 7, 1933, page 17. Brief note commenting on the recent revisions made in a series of "Provisional Rules for Electric Arc-Welding in Ships" issued by the British Corporation Register of Shipping and Aircraft. LFM (7b)

Electrically-Welded Spheres. *Engineering*, Vol. 135, June 23, 1933, page 688. Illustrated article briefly describing construction of structures with curved surfaces using electric welding which has proved to be more advantageous than riveting. LFM (7b)

Welding Non-Ferrous Process Piping. *Oxy-Acetylene Tips*, Vol. 12, Sept. 1933, pages 197-201. Usual practice for welding Al and Cu pipes for corrosive fluids is described; Al fittings were used for Al pipes, bronze and silver soldered welds used for Cu. Ha (7b)

Welding of Commercial Yellow Brass Pipe. *Oxy-Acetylene Tips*, Vol. 12, Nov. 1933, pages 245-248. Experimental studies into the best mode of welding for ordinary brass pipe (67% Cu, 33% Zn) point to the fact that the bell-and-spigot joint is not as efficient as the butt type joint, particularly in larger pipes with more than 1/8" wall thickness. As the butt-joint is also cheaper to make it is recommended to be used for all pipes with more than 1/8" wall. Test results of tensile strength with various welds are reported. Ha (7b)

Welding of Brass and Bronze Sheets. H. Herrmann. *Metal Industry*, London, Vol. 43, Aug. 18, 1933, pages 145-148. 2 problems are to be considered in welding sheet brass and sheet bronze: the introduction of small quantities of some metal or metalloid exhibiting a larger deoxidizing effect than Zn or Sn respectively which is able to protect these metals against the oxidizing influence of the cuprous oxide on the one hand and of the welding flame and the atmosphere on the other; and the use of a flux which, apart from protecting the fused weld metal against the oxidizing effect of the torch and the atmosphere, possesses a dissolving action on the zinc oxide or tin oxide produced in the welding process. The means of obtaining these ends by proper composition of fluxes containing Al and P and of welding rods, the characteristic differences in brass and bronze welding and the precautions to take to avoid buckling of the sheets are discussed in detail. Ha (7b)

Structural Steel Welding in Germany. Otto Bondy. *Welder*, Vol. 5, Oct. 1933, pages 19-28. Experience during the last 3 years with welded structures in Government and State Railway work is described and many examples of big halls, stations, bridges, etc., illustrated. On the basis of these experiences the factor for permissible stresses in welds expressed as percent of those for the parent metal has been increased for buttwelds from 0.6 to 0.75 under tension and bending, from 0.75 to 0.85 under compression, and from 0.5 to 0.65 under shearing stress; for fillet welds from 0.5 to 0.65 for all kinds of stresses. Ha (7b)

Present State of Electric Welding (Der heutige Stand der Elektroschweissung) O. Bondy. *Elektrizitätswirtschaft*, Vol. 32, Aug. 25, 1933, pages 366-369. Writer reviews the most outstanding advances as illustrated by the electric exhibition at Essen referring to adoption of welding in locomotive construction, ship building, structural engineering as well as to novel welding machines placed on the German market. EF (7b)

Arc Welding in the Erection of Six Steel Towers. F. O. Blair. *Refiner & Natural Gasoline Manufacturer*, Vol. 12, Jan. 1933, pages 16-17. Six steel stills, 8' x 40', were erected at the Standard Oil Co. (Ind.) plant at Laramie, Wyo., using arc welding at a saving of $528, as compared with steel brackets, or $708, as compared with cast iron. VVK (7b)

Welding of Boiler Plate with Arcatom Process (Ueber Kesselblechschweissung nach dem Arcatom -Schweissverfahren) H. Blomberg. *Elektrowärme*, Vol. 3, July 15, 1933, pages 230-232. The atomic H-process has shown particularly good results in welding boiler plates which retain thereby all good tensile properties. This is ascribed mainly to the low content of Ni in the weld which is excluded by the H around the electrodes. Electrolytic Fe and Fe's with abnormally low C and Mn content, however, have not been amenable to this method of welding on account of high losses by the sputtering flame. Ha (7b)

Electric Welding in Construction of Steam Boilers and Pressure Vessels and Their Testing (Die elektrische Schweissung im Dampfkessel- und Druckgefässbau und ihre Prüfung) E. Block. *Elektrowärme*, Vol. 3, July 1933, pages 169-172. Principally employed for boilers and pressure vessels are electric arc and resistance welding. Standards for tests and testing method, in particular X-ray testing are discussed. Ha (7b)

Riveting (7c)

New Countersunk Riveting Process for Sheet Metal. A. Eyles. *Metal Industry*, London, Vol. 43, Aug. 4, 1933, page 99. The flat rivet head is forced flat into the 2 thin sheets which sink together into a cup shape formed in the top tool without distorting the sheets which remain dead flat. A new cup head is formed on the rivet shank by means of a cupped depression in the top tool. The tool is operated pneumatically. The method is applicable to thin sheets of Al, brass, duralumin, Monel metal, Ni, stainless steels, Cr and mild steel. An example with No. 20 gage sheet steel is illustrated. Ha (7c)

Rivets: Their Significance in Shipbuilding. R. Boardman. *Mechanical World & Engineering Record*, Vol. 91, Feb. 19, 1932, pages 174-176. See *Metals & Alloys*, Vol. 4, June 1933, page MA 182. Kz (7c)

Rivet Bolt Driven Cold with 5-Pound Hammer, Shows High Strength. *Steel*, Vol. 91, July 25, 1932, page 28. Description of new rivet-bolt fastener for lap structural joints consisting of standard rivet head, oversized ribbed shank, and lock type threaded section. JN (7c)

Calculation of Riveted Plate Joints (Die Berechnung genieteter Stegblech-Stossverbindungen) R. Krell. *Bauingenieur*, Vol. 14, June 9, 1933, pages 313-316. For the riveted joints considered a method of calculation is described differing from calculation methods used so far. The new method takes into consideration the rivet stresses actually present and means a considerable saving of rivets. GN (7c)

Experience Gained on the Bottom Riveting Machine (Erfahrungen mit der Bodennietmaschine) R. Kruschen. *Die Wärme*, Vol. 55, Nov. 26, 1932, pages 822-823. Joints made with the bottom riveting machine are inferior to those accomplished by ordinary or shell riveting machines with respect to their filling out the rivet hole. EF (7c)

Riveting of Boilers and Other Pressure Vessels. E. Ingham. *Mechanical World & Engineering Record*, Vol. 93, Feb. 17, 1933, pages 152-154. Precautions which must be taken to insure good work by machine riveting are summarized. A new process of pin riveting, involving rivets which are plain lengths of steel cropped square at the ends, which has advantages over the ordinary methods which use preformed heads is described. Pin rivets are subjected to only one heat. The formation of a head at each end yields a good flow of metal throughout and tightly fills hole. Pressures needed for the pin system are less, meaning less liability to injuring plates. Special machinery employed is discussed. Kz (7c)

Pressures Required for Heading Duralumin Rivets. George A. Fries. *Machinery*, Vol. 39, Sept. 1932, page 11. These rivets are used extensively in aircraft construction. Briefly considers method of calculating pressures for heading. Table shows pressures required for various sizes. RHP (7c)

Modern Riveting Technique for Foreign Light-metal-airplanes. (Über neuzeitliche Nietverfahren im ausländischen Leichtmetall-Flugzeug.) W. Pleines. *Zeitschrift für Flugtechnik und Motorluftschiffahrt*, Vol. 24, Feb. 14, 1933, pages 65-75. Discusses different techniques of cold riveting, which have been developed in foreign countries, and successfully strives at gathering results gained by practical experiences. Although duralumin has been widely employed in airplane construction difficulties arose in regard to corrosion resistance of rivets when exposed to the influence of seawater. The fact that among good rivets 10-20% were badly corroded led to investigations in different directions with the result that the most important factor is considered to be the riveting technique itself. Methods of heat treatment and quenching are discussed in connection with precautions to be taken in construction and protective coating. Means of testing rivets are given and the influence as well as prevention of age hardening of duralumin rivets with research work carried out in this line is dealt with. Discussing details of construction the Bergue patented countersunk riveting process and pneumatic riveting machines are dealt with. Kz (7c)

Rivets of 18-8 Chrome-Nickel Steel Finding Use in Hull Construction. *Steel*, Vol. 92, Mar. 20, 1933, page 27. Rivets should be heat treated to produce a fine structure of maximum toughness and impact strength. Full size specimen of the bar should withstand upsetting from a length 1⅓ diameters to ½ diameter without cracking, when heated to 2100°-2200° F. Rivets up to ⅝ inch may be heated or upset cold. Larger rivets should be driven very hot and if possible finished about 1800° F. Heating of rivets for hot driving should be done in muffle-type furnace with pyrometric control. Rivets heated by electrical resistance are more satisfactory. Use of a large hammer and rapid working are essential. In hard driving with a pneumatic hammer, it may be necessary to heat to 2200°-2250° F. MS (7c)

FINISHING (8)

H. S. RAWDON, SECTION EDITOR

Pickling (8a)

1 **Concrete Tanks Lined with Asphalted Tile Found Suitable for Pickling.** *Steel*, Vol. 93, Sept. 25, 1933, page 29. Pan-Pacific Piling & Construction Co., Wilmington, Cal., has developed tile which is resistant to H_2SO_4. MS (8a)

Sandstone Blocks for Pickling Baths. C. CAMPBELL. *Sands, Clays & Minerals*, Vol. 2, Feb. 1934, pages 43-44; *Iron & Coal Trades Review*, Vol. 128, Mar. 16, 1934, page 450. Tanks made of slabs of sandstones were found to be particularly effective in resisting acid corrosion under almost all circumstances, even HCl, but the stones must be specially selected to make sure that no constituents liable to be attacked may be present. Practical points to be observed in joints are given. Ha (8a)

2 Cleaning, including Sand Blasting (8b)

Cleans Steel Castings by Washing with Water at High Pressure. *Steel*, Vol. 93, Dec. 4, 1933, pages 23-25. **Cleans Steel Castings by Washing.** *Foundry*, Vol. 61, Nov. 1933, pages 16-17, 60, 63. See *Metals & Alloys*, Vol. 5, Feb. 1934, page MA 76. MS+VSP (8b)

New Machine Cleans Billets Rapidly and at Low Cost. *Steel*, Vol. 93, Sept. 4, 1933, page 32. A large steel company uses the "Airless Wheelabrator," manufactured by the American Foundry Equipment Co., Mishawaka, Ind. Machine utilizes centrifugal, tangential, and air-dynamic forces rather than compressed air for impinging the abrasive against the work. It replaces pickling, wire brushing, abrasive scrubbing, and other methods of cleaning. Billets are fed into the
3 machine on motor-driven rolls at about 60 ft./min. Output is more than 20 tons/hr. In cleaning billets, 38 grit, crushed cast shot was found to be most suitable abrasive. MS (8b)

Electrolytic Degreasing and the Limits of Its Applicability (Die elektrolytische Entfettung und die Grenzen ihrer Anwendbarkeit) K. W. FROEHLICH. *Mitteilungen des Forschungsinstituts und Probieramts für Edelmetalle*, Vol. 7, Jan. 1934, pages 111-120. Certain irregularities and defects encountered in the plating of material degreased by electrolytic process were investigated. Failures especially characteristic of Cu and Ag surfaces were traced to certain impurities. Local spongy metal developed by H in the electrolytic process, O and P in Cu and Ag (Cu_2O and Cu_3P) are responsible. These conditions are discussed exhaustively. If alloys (containing such impurities) are first immersed in a
4 boiling 10% solution of potassium cyanide, Cu_2O and Cu_3P are dissolved and a silver film is formed, electrolytic degreasing can then be applied. This trouble was, however, not observed with Ni or Cu plating even if the same impurities were present. A number of micrographs illustrate the conditions. Ha (8b)

The Properties and Uses of Non-Inflammable Solvents. *Industrial Chemist*, Vol. 9, Oct. 1933, pages 349-350; Dec. 1933, pages 448-451. The chemical and physical properties of chloro-hydrocarbons are discussed, together with industrial applications. Data are given to show that the corrosive action of trichlorethylene on metals is almost negligible. RAW (8b)

An Inexpensive Dust Control System. H. GLOVER. *Modern Machine Shop*, Vol. 6, Dec. 1933, pages 18-20. Describes a simple arrangement of 2 boxes
5 for collection of the dust in sandblasting. Ha (8b)

Polishing & Grinding (8c)

Contribution to the Determination of the Degree of Smoothness of Metal Surfaces (Ein Beitrag zur Bestimmung des Glättegrades bearbeiteter Werkstückflächen) E. FRANKE. *Oberflächentechnik*, Vol. 11, Feb. 6, 1934, pages 25-27. The advantage of very smooth surfaces of machinery parts which glide on one another is two fold; they do not wear so quickly and their endurance strength is greater because the danger of fine surface cracks which are usually the starting points of fatigue fractures is more remote on account of the smoothness of surface. Also, the accuracy with which a measurement can be made is much greater on a
6 smooth surface. In reviewing methods of testing surface smoothness, a description is given of a recently developed acoustic method in which a needle is carried over the surface and the vibrations transformed into sound; the smoother the surface, the higher the pitch. Herbert's pendulum method for measuring relative surface hardness and smoothness is described. A very high degree of smoothness (on axles, etc.) can be produced by a new method (prägepolieren) whereby the surface is polished under the high pressure of 3 rolls. Ha (8c)

Circular Grinding Wheel Composed of Segments (Ringschleifscheibe aus Segmenten) H. O. SCHOLL. *Oberflächentechnik*, Vol. 11, Feb. 20, 1934, pages 42-43. The wheel is composed of suitably shaped segments which prevents breaking as often occurs in a wheel of a single piece, and it permits also better
7 utilization. Ha (8c)

Perforated Grinding Wheels with Steel Skeleton (Perforierte Schleifscheiben mit Stahlskelett) H. O. SCHOLL. *Oberflächentechnik*, Vol. 11, Mar. 6, 1934, page 53. Grinding wheels of ceramic masses have a steel skeleton embedded in the ceramic mass to prevent bursting. The ceramic mass is not solid but perforated; better attack is obtained as the ground-off particles settle in the holes. Ha (8c)

Precision Grinding: Methods, Machines and Uses (La Rectification de Précision: Méthodes, Machines, Champs d'Emploi) *L'Usine*, Vol. 42, June 2, 1933, pages 35-37; June 9, 1933, pages 34-37; June 16, 1933, page 34. An exhaustive description of modern methods and machinery for correcting and machining to exact dimensions by grinding. Ha (8c)

Metal Grinding Machines at the Leipzig Fair (Schleifmaschinen für Metallbearbeitung auf der kommenden Leipziger Messe) *Technische Blätter der deutschen Berg-*
8 *werkszeitung*, Vol. 24, Feb. 25, 1934, pages 110-112; Mar. 4, 1934, pages 139-140. After discussing in general the 3 main types of metal grinding machines, (1) round grinders used in grinding outside or inside of cylindrical or conical machinery parts, (2) face grinders and (3) centerless grinding machines, a large number of various makes of new types of German grinding machines are described and the uses shown, as crank shaft grinding, rolling-mill roll grinding, tool grinding, locomotive frame grinding, etc. GN (8c)

Lapping Wheels. *Automobile Engineer*, Vol. 23, May 1933, page 184. Briefly describes and illustrates a lapping wheel developed by Messrs. A. C.
9 Wickman, Ltd., for lapping tools of the W carbide type. Lapping wheel is formed of a non-metallic bond charged to a certain depth with diamond dust. RHP (8c)

Polishing Powders and Earths. ARTHUR JONES. *Sheet Metal Industries*, Vol. 7, Sept. 1933, pages 309-310. Discusses clays, chalks and whiting, cuttle-fish, rottenstone, French chalk, silica flosses, tripoli, rouges, and pumice powder. AWM (8c)

Modern Grinding Wheels (Neuartige Schleifscheiben) H. HORSTMANN. *Die Eisenbahn Werkstätte*, Vol. 41, Aug. 20, 1933, pages 139-140. Grinding wheels with artificial resins (Bakelite) as binding agent are more and more favored. Their superiority over wheels with ceramic binders is based not only on the excellent binding ability of Bakelite but also on the presence of pores which permit the formation of chips without smearing of the grinding wheel or scratching of the metallic work. Grinding wheels with Bakelite binders are more
10 flexible and thus more suitable for thin, elastic wheels. They compete with grinding wheels utilizing rubber binding agents now widely used for working of castings. Bakelite grinding wheels can be made in 2 to 3 days instead of several weeks as is necessary with ceramic binders, permit higher revolution speeds and can be made very porous by employing temporarily hollow glass balls as filling material during manufacture. WH (8c)

Grinding Capacity and Working Efficiency of Sandpaper (Schleifleistung und Arbeitsvermögen von Sandpapier) W. WALTER. *Zeitschrift Verein deutscher Ingenieure*, Vol. 77, July 1, 1933, pages 713-717. A method was developed to measure the operating properties of sandpaper for use as a basis for calculating cylindrical grinding and polishing machines. The basis of comparison was the time required to decrease the grinding capacity ½. This coincides practically with the limit of usefulness of the sand-paper. An attempt is made to design a grinding machine from the results given. Ha (8c)

Elutriation as An Aid to Fine Grinding. A. L. CURTIS. *Sands, Clays & Minerals*, Vol. 2, Feb. 1934, pages 21-26. The kinetic elutriator of Andrews was tested with regard to its effectiveness in determining the efficiency of a grinding process. After 10 grinds (about 5 hrs.) 90% of the ground material passed a 200 mesh sieve. The tests showed clearly that the presence of very fine particles in a mill have a detrimental effect on the reduction of coarse and medium grains by forming a cushion which resists action of further grinding. The constant removal of fine particles by hydraulic or pneumatic methods should, therefore, increase the efficiency of the mill. Ha (8c)

High Grade Finishing Work on Bearings, Axles and Axle Journals (Feinstbearbeitung der Lager, Zapfen und Achsschenkel) OTTO HEFT. *Organ für die Fortschritte des Eisenbahnwesens*, Vol. 88, Aug. 15, 1933, pages 315-317. Author states that a brightly shining, extremely smooth surface of bearings and axles is generally attained by wear in service calling for a later adjusting. Attention is directed to the new Krupp "burnishing" (Prägepoliern) equipment. A critical comparison between lapping and honing is made, typical examples of unsatisfactorily finished axle surfaces are presented and 8 factors are pointed out on which the success of honing depends. EF (8c)

Equipment for "Burnishing" of Axles and Axle Journals (Einrichtungen zum Ziehschleifen von Zapfen und Achsschenkeln) ADOLF RUMMEL. *Organ für die Fortschritte des Eisenbahnwesens*, Vol. 88, Aug. 15, 1933, pages 317-320. Abundantly illustrates and describes 2 machines designed in the German State Railroad Repair Shops at Karlsruhe for the finishing operations on (a) driving and crank pins, (b) axle journals of wheel sets. Detailed data on expenses of the old and new working method are given with reference to German conditions. EF (8c)

Electroplating (8d)

A Cyanide-Free Bath for the Deposition of Copper on Steel. COLIN G. FINK & CHAAK Y. WONG. *Metal Industry*, London, Vol. 43, Aug. 4, 1933, page 110. The tendency of Cu to be deposited on a more electronegative metal, such as steel, by displacement—according to $Cu\ SO_4 + Fe = Fe\ SO_4 + Cu$—which gives a loose and non-adherent deposit, was counteracted by a new kind of bath containing disodium disquodioxalatocupriate (called "oxalato") 2.7 oz./gal., $Na_2\ SO_4$ 2.0 oz./gal. and boric acid 2.7 oz./gal.; Na_2SO_4 improves the conductivity while boric acid acts as a buffer. With 10 amp./sq. ft. it takes less time to deposit a sufficient thickness of Cu in the oxalato bath than in the cyanide bath, for a current density of 30 amp./sq. ft. the reverse is true. The amount of Cu deposited with the oxalato bath is not proportional to time of plating but tends to approach a maximum weight so that high current densities are not required; the latter favored even formation of black Cu deposits on the edges of the iron plate. 10 amp./sq. ft. and a plating period of 60 sec. were found to give very satisfactory results. Ha (8d)

Chromium Plating for Increasing Wear Resistance. *Machinery*, London, Vol. 40, Aug. 4, 1932, pages 549-553. Illustrated article deals at length with methods of Cr plating of small tools and gages. Results proving the efficiency are discussed. Kz (8d)

The X-Ray Analysis of Electrodeposited Alloys. CHARLES W. STILLWELL. *Metal Industry*, N. Y., Vol. 31, Feb. 1933, pages 47-50. The general principles involved in the application of X-ray analysis to the study of electrodeposited alloys of Ag-Cd were pointed out. Increasing the current density increased Cd in deposit; increasing the temperature increased Ag in deposit. The 2 metals were always present in the electrodeposit in the form of a solid solution or compound, the predominant phase being the same as that in a thermal alloy, but contaminated with additional compounds or solid solutions which cannot be predicted from the chemical composition. The burnt deposits formed when current density or temperature became too high were crystalline compounds or solid solutions together with large amounts of $Cd(OH)_2$. In the Ag-Cd deposits there was no evidence of the presence of grains less than 10^{-5} cm. or greater than 10^{-3} cm. in size. There was no evidence of the electrodeposit alloying with the copper cathode. PRK (8d)

Theories of Addition Agent Action. ROBERT TAFT. *Transactions Electrochemical Society*, Vol. 63, May 1933, pages 75-85. There are 2 types of addition agent action. In one, the addition agent is actually deposited and included within the metal deposit. Adsorption of addition agent by metal seems to be the best explanation of this type. In the second type, the addition agent is reduced simultaneously with the metal ion, but is not included in the deposit. The products of reduction, however, adhere momentarily to the cathode surface thus interfering with the growth of metal crystal and producing a smoother or brighter deposit. An example of this type of addition agent is 0.1 N. NH_4NO_3 in acid sulphate Cu electrolyte. LCP (8d)

Some New Organic Addition Agents for Cadmium Electroplating. R. A. CLAUSSEN & H. L. OLIN. *Transactions Electrochemical Society*, Vol. 63, May 1933, pages 87-97. New addition agents for Cd plating were compared with casein, bindex and gulac. Among them were Steffen's waste (residue from beet molasses after sugar recovery) and concentrated steep water produced in the initial soaking of corn in starch manufacture. Steffen's waste compares favorably with gulac giving a higher throwing power qualitatively. Current density must be 3.5 to 5.0 amp./dm.^{2} for best results. Steep water also gave a better throwing power than gulac, although gulac gave the brightest and whitest deposit. Casein and bindex have a narrower current density range than either gulac, Steffen's waste or steep water. LCP (8d)

Throwing Power of Electrolytic Baths. (Beiträge zur Kenntnis des Streuvermögens von galvanischen Bädern.) V. ENGELHARDT & N. SCHOENFELDT. *Wissenschaftliche Veröffentlichungen aus dem Siemens-Konzern*, Vol. 12, Feb. 1933, pages 34-38. The throwing power of an electrolyte, was investigated with an acid Cu bath (100 g. $CuSO_4$ and 10 g. H_2SO_4/l.), an alkaline Cu bath (67 g. $CuSO_4$, 34 g. Na_2CO_3, 75 g. KCN/l.), and acid Ni bath (308 g. $NiSO_4$, 30 g. $MgCl_2$, 98 g. $MgSO_4$, 31 g. H_3BO_3/l.), and a chromic acid bath (350 g. CrO_3, 2 g. H_2SO_4/l.); current density for the first 3 was 0.5, for the last bath 10 amp./dm.^{2}. The determining influence of primary and secondary current distribution, the dimension of the tank and of the electrodes was again confirmed. Results of all tests are shown in curves which permit choosing practical distances for plating. Ha (8d)

Electroplated Coatings Combat Corrosion and Provide Attractive Finishes. GUSTAF SODERBERG. *Steel*, Vol. 92, May 1, 1933, pages 29-30, 32. **Metallic Coatings Combat Corrosion and Provide Attractive Finish.** *Machine Design*, Vol. 5, Apr. 1933, pages 18-21, 58. Discusses important points which must be considered in electroplating. These are choice of deposit; specifications; depth of recesses; shape of inside corners; shielding of one area by another; gas-pockets; proper draining; racking; and stability of suspension. MS+WH (8d)

Plating on Aluminum (Galvanische Niederschläge auf Aluminium) W. KRAUSE. *Mitteilungen des Forschungsinstituts und Probieramts für Edelmetalle*, Vol. 7, Oct. 1933, pages 87-89. See "Electroplating on Aluminum," *Metals & Alloys*, Vol. 3, Mar. 1932, page MA 65. Ha (8d)

The Electrodeposition of Cobalt. *Metal Industry*, London, Vol. 44, Feb. 9, 1934, pages 164-166. The nature of Co deposits is reviewed. Co is deposited very easily; the whiteness of the deposit depends greatly upon the nature of the electrolyte. Co can be deposited with current density as high as 150 amps./ft.^{2} as compared with 10 amps./ft.^{2} for Ni, and the deposit is harder and more brilliant than Ni; also, its throwing power is much superior to that of Ni. The solubility of cobalt ammonium sulphate is higher than that of Ni, the ratio being 171:66 which accounts for more rapid deposition. Best figures obtainable on relative hardness for plated Co is 750 while steel has 625 and plated Cr 2000 on a scratch hardness scale. Good dense deposits are obtained at pH-6; below 4.5 the deposit was poor. Deposition of alloys of Co and Cr and of Co and Ni have been made. Alloys of 55-77% Ni and 45-25% Co are silver-white and are 3 times as hard as Ni and also more resistant to corrosion. 19 references. Hz (8d)

The Plating of Zinc and Zinc Base Die Castings. L. WRIGHT & F. TAYLOR. *Metal Industry*, London, Vol. 42, Mar. 31, 1933, pages 355-358; Apr. 14, 1933, pages 405-406. Discusses difficulties in direct Ni plating of Zn together with experiments to find a method by which die castings could be Ni plated without an intermediary Cu or brass deposit. The following solution was found to give most satisfactory and consistent results: Nickel sulphate 75 g./l., sodium sulphate (10 H_2O) 200 g./l., ammonium chloride 12 g./l., boric acid 10 g./l. In a solution having a pH value of 5.8-6.2, with cast anodes, good deposits of ductile Ni were obtained which could be readily Cr plated after polishing. Ha (8d)

Resistance Measuring Method for Technical Electrolytic Baths (Widerstandsmessmethode für technische Elektrolysebäder) FRITZ WOEHR. *Zeitschrift für Elektrochemie*, Vol. 39, Sept. 1933, pages 756-758. Describes a method and gives its theory for the measurement of the ohmic resistance of electrolytic baths up to 13,000 amp. during operation. Ha (8d)

Chromium Plating in the Industry (Forkromning i Industrien) E. SCHOEPKE. *Teknisk Ukeblad*, Vol. 80, Jan. 11, 1934, pages 16-17. Discusses chemical and physical properties of electro-plated chromium and lists the most common applications. Deposits of chromium on bearings, gears, and other parts exposed to wear prolong their life and insure smoother operation even at high temperature and with defective lubrication. Chromium plating is now widely used for pressed glass molds; as high as 300,000 pieces have been made in one mold. Operating temperature of these molds is generally 600°-700°C., although very little oxidation of the chromium surface takes place below 1,000°C. Press molds for hard rubber and plastics are likewise chromium plated. Another advantage of these molds is their unusual smoothness which insures a product of high quality and permits easy release from the mold. BHS (8d)

Chromium Plating (Ueber Verchromung) MAX SCHLOETTER. *Oberflächentechnik*, Vol. 11, Feb. 20, 1934, pages 40-41. The fact that the chromium deposit on chromium plated objects of brass, especially often-used handle bars, rails, etc., often spalls off, must be ascribed to a H layer formed during plating between the brass surface and Cr deposit; an intermediary layer of Ni does not help very much as Ni, too, has a tendency to dissolve H. A H-layer may form between Ni and Cr, and H diffuse through the Ni layer to the brass if there is not enough Ni to absorb all H. The pressure with which H diffuses through electrolytically deposited Ni can amount up to 10 at. which explains easily that the Cr deposit is cracked and thrown off. The Ni layer must be thick enough to absorb all H liberated in Cr-plating; the difference in the expansion coefficient of the layers, often blamed for causing spalling, has nothing to do with the matter. Degreasing by electrolysis is not to be recommended, bright Ni-plating should be applied so that the object can be brought directly into the Cr-plating bath. Ha (8d)

Practical Problems Involved in Commercial Electroplating on Aluminum. H. K. WORK. *Metal Industry*, London, Vol. 42, May 12, 1933, pages 499-503; May 26, 1933, page 550. In a discussion on qualities and possibilities of plated Al, practical shop experiences were exchanged. The formation of compounds, Ni and Al, seems possible, a selective attack by etching agents revealed some complex alloy. Although an apparently satisfactory Ni deposit could be deposited the article did not last long in service; sooner or later it became unsightly and the Ni flaked off locally on account of poor adhesion. Sandblasting, previous to plating, gave very good results, especially Zn adhered very well. Duralumin with a heavy Ni deposit will well stand heat treatment up to 500°C. This seemed even to improve the adhesion of the electrodeposit. Ha (8d)

Platinum Plating. ALAN E. W. SMITH. *Metal Industry*, London, Vol. 43, Sept. 1, 1933, pages 201-202. Pt plating is similar to Cr plating: both being non-corroding with failures occurring through pores in the deposit. The best Pt deposits are obtained on an Ag deposit which makes the base metal of little importance as Ag can be deposited on almost any metal. Pt plating retains its original brilliance for long time in a dry atmosphere as usually found indoors; in outdoor service periodic wiping to keep the surface bright is necessary. Chemicals may attack the deposit as a result of its porosity. Cr plating is harder and cheaper but Pt plating has a more pleasing color and throwing power of the solution is better. Ha (8d)

Contribution to the Study of Chromium Plating (Contribution a l'étude du chromage éléctrolytique) M. LEMARCHANDS & M. ABRAMOVITCH. *Bulletins de la société chimique de France*, Vol. 53, May 1933, pages 407-431. Chromate salts are not suitable for electrodeposition of Cr and reduction of the chromate electrolytically previous to deposition is not economical. Direct deposition from the chromic ion is impossible. Cr must be in the chromous form, this yields excellent results. To secure a partial initial reduction of the chromic ion, a small quantity of a chromous salt must be added to a chromic electrolyte. Addition of 0.05% NH_4Cl is also recommended. The bath should contain 0.71 g. Cr per l. Deposition with a Cr anode upon a Cu cathode carried out at room temperature yields adherent and hard deposits. Agitation of the electrolyte and turning the cathode from time to time aids in securing uniform deposits. EF (8d)

Electrolytic Deposition of Metallic Niobium. II. (Ueber die elektrolytische Abscheidung von metallischem Niob. II.) N. ISGARISCHEW & G. E. KAPLAN. *Zeitschrift für Elektrochemie*, Vol. 40, Jan. 1934, pages 33-36. Previous methods for practical electrodeposition of Nb were revised (*Zeitschrift für Elektrochemie*, Vol. 39, 1933, page 233) electrolytes with citric acid and oxalic acid, and alkaline solutions did not deposit Nb entirely on the cathode; on parts receiving no deposit of Nb compounds formed from which Nb could not be separated by electrolysis. Solutions with citric acid did not show this result to the same pronounced degree. Ha (8d)

Methods and Concepts in the Development of Electrodeposition. LESLIE B. HUNT. *Metal Industry*, London, Vol. 44, Jan. 5, 1934, pages 13-14. Historical development, particularly the last 100 years since Faraday, is outlined, modern theories on the mechanism of electrodeposition are discussed. Ha (8d)

The Adhesion of Electrodeposited Coatings to Steel. A. W. HOTHERSALL. *Sheet Metal Industries*, Vol. 7, Nov. 1933, pages 419-421, 430; Dec. 1933, pages 483-484. 16 references. A paper at the 64th General Meeting of the American Electro-chemical Society. (Slightly abridged) A degree of adhesion approximating the strength of basis metal or of the deposit, whichever is weaker, can be obtained by suitable cleaning methods. Poor adhesion is considered to be caused by mechanical weakness of the topmost layers of the basis metal or of the initial layers of the deposit, or the presence of a film of foreign matter between the two metals. Causes are discussed in detail. AWM (8d)

Cold or Hot Chromium Plating? (Kalt oder warm verchromen?) PAUL HOPPE. *Metallwaren Industrie & Galvano Technik*, Vol. 31, Aug. 1, 1933, pages 298-299. Warns against Cr plating at low temperatures. EF (8d)

Barrel Plating of Zinc with Nickel. ALBERT HIRSCH. *Iron Age*, Vol. 131, June 22, 1933, page 991. See "Nickel Plating of Fabricated Zinc in a Barrel," *Metals & Alloys*, Vol. 5, Feb. 1934, page MA 49. VSP (8d)

Plating Defects in Chromium-plated Brass Parts (Plattierungsfehler an verchromten Messinggeräten) WILHELM HERRMANN. *Metallwaren Industrie & Galvano Technik*, Vol. 31, July 15, 1933, pages 277-278. Note on discoloration of Cr plated brass. Cr coatings are claimed to be stable if a reasonably thick intermediary layer of Ni is utilized. EF (8d)

Experiments on the Electrolytic Deposition of Chromium Alloys from Baths Free of Chromic Acid (Versuche zur Elektrolytischen Abscheidung von Chromlegierungen aus chromsäurefreien Bädern.) H. CASSEL. *Oberflächentechnik*, Vol. 10, July 4, 1933, page 158. See "Experiments on the Galvanic Precipitation of Chromium Alloys from Chromic Acid-free Electrolytes," *Metals & Alloys*, Vol. 5, Mar. 1934, page MA 88. Ha (8d)

The Electrodeposition of Palladium. R. H. ATKINSON & A. R. RAPER. *Metal Industry*, London, Vol. 42, June 9, 1933, pages 595-598. See *Metals & Alloys*, Vol. 5, Feb. 1934, page MA 49. Ha (8d)

The Electrodeposition of Rhodium. R. H. ATKINSON & A. R. RAPER. *Metal Industry*, London, Vol. 44, Feb. 16, 1934, pages 191-194; Mar. 9, 1934, pages 281-282. Rh is not attacked by any acid, not even by aqua regia; it has a higher reflectivity than Pt, the deposit is nearly as white as Ag and whiter than Pt or Pd. The deposit is stable at atmospheric temperature, and oxidizes only superficially at 600°C. At present an electrolyte of ammonium rhodonitrite is used; detailed description of the preparation is given on account of the difficulty of getting the metal into solution. Working temperature of 40°C. and a current density of 5 amps./ft.^{2} are recommended; the deposits are almost free from porosity. Cathode current efficiency is about 45%, a liberal evolution of H taking place. Articles are plated for 5-15 min., the latter gives deposits about 72 mg. of Rh/dm.^{2} (approx. 16 in.^{2}); normal practice requires only about 32 mg./dm.^{2}. The bath has a good throwing power and can be used for plating any of the precious metals, Ni and Ni-base alloys, Cu and Cu-base alloys. It is not suitable for Zn-base alloys on account of the high acidity of the electrolyte; a proper undercoat is required. Satisfactory deposits thicker than 0.001" have so far not been obtained, cracks or milky deposits being developed. Usually a Pt anode is used; the bath is not very stable. Prices of Rh plating are about the same as Pt plating. It is used for plating metal reflectors and also jewelry. In the discussion some practical questions concerning undercoat and stripping of defective deposits were raised; the latter is not yet possible. Ha (8d)

The Mechanics of Adherence in Metal Plating (Die Mechanik des Haftvermögens bei der Metallplattierung) K. ALTMANNSBERGER. *Oberflächentechnik*, Vol. 11, Jan. 16, 1934, pages 15-16. The problem of good adherence to the surface of a metal of another layer is discussed for varnishing, enameling and electroplating. Like galvanizing, electroplating is considered to involve alloying between base metal and cover, the crystal lattices grow together. H in the deposit retards the formation of an alloy. One reason for low adhesion is the tendency of electro deposited metals to contract during deposition, in particular Ni, Co, Fe, Cr, etc. which absorb H easily; this causes internal stresses. The best adhesion is obtained when the formation of solid solutions between base and cover is as complete as possible, that is, the crystals of the base metal continue, during electrodeposition, to grow in the same crystal lattice. For this reason the metal surface must be as clean as possible. Adhesion is determined by measuring the force required to lift a deposit off the base metal which can be done, according to the method by Schloetter, by means of a little rod of Wood's metal soldered to the deposit at 70°C. Some tests by twisting, Brinell test, Erichsen test are briefly mentioned. Ha (8d)

Production of Silver-Cadmium Electro-platings (Zur Herstellung elektrolytischer Silber-Kadmium-Plattierungen) Ralph W. Harbison. *Deutsche Goldschmiedezeitung*, Vol. 36, Dec. 2, 1933, pages 525-526. Discusses various essential points in obtaining good Ag-Cd platings; (1) Use of pure salts in electrolyte, (2) constant slow motion of electrolyte, too rapid stirring as established by practical experience, plating may become coarsely crystalline, (3) proper metal content of electrolyte, increase in Cd content of electrolyte increases Cd content of deposit more rapidly than corresponds to increase in electrolyte, (4) with constant Ag and Cd content in electrolyte, an increase in current density gives a higher Cd content in deposit than corresponds to increase of current density, (5) Cd content of deposit decreases with increasing temperature of electrolyte, but other conditions being constant the properties are then impaired. GN (8d)

Palladium as Plating Metal in Precious Metal Industry (Palladium als Plattierungsmetall in der Edelmetallindustrie) Ralph W. Harbison. *Deutsche Goldschmiedezeitung*, Vol. 37, Jan. 13, 1934, pages 32-34. One of the greatest difficulties in applying Pd as plating metal for less noble, i. e. electro-positive, metals, is tendency toward porosity. Best base metal for Pd plating is Ag, Cu and most Cu alloys, when carefully treated, give dense deposits whereas Fe, Zn and Sn alloys must be plated first with Cu or Ag. Various types of Pd-plating methods with soluble and insoluble anodes are considered at length. Success depends on preparation of surfaces to be plated. Oxides, sulphides, dust, oil etc. must be removed first. The easy removal of Pd plating is an advantage. Field of application of Pd plated parts is given. GN (8d)

Silver and Gold Plating of Aluminum, Duralumin, etc. (Versilbern und Vergolden von Aluminium, Duralumin, usw.) G. Huth. *Deutsche Goldschmiedezeitung*, Vol. 37, Jan. 13, 1934, pages 31-32. Former difficulties in electrodepositing precious metal on light metals are eliminated by first oxidizing surface of the base metal by chemical or electrolytic methods. The natural oxide layer on Al is not suitable for subsequent Ag or Au plating, i. e. the oxide layer must be artificially produced. Artificial oxidation of Al is attained by electrolyzing either in 3% oxalic acid solution or 10% chromic acid solution, or by simply chemically treating at 100°C. in aqueous solution containing 1% NH_3 and 3% NH_4Cl. Parts may then be Ag plated by dipping in $AgNO_3$ solution and heating to about 160°C. whereby Ag is deposited. Similarly gold platings are made. Advantage of new method is that parts may also be partially Ag or Au plated. GN (8d)

Rustproofing by Electroplating. *Steel*, Vol. 93, Aug. 28, 1933, pages 41-42. **Rustproofing Accomplished Without Use of Cadmium.** *Steel*, Vol. 93, Sept. 4, 1933, page 41. Note on process developed by the Northern Distributing Co., Seattle, Wash., involving electrodeposition of an alloy, "Electroloy," containing non-ferrous metals other than Cd. (Composition not stated.) Applicable to all ferrous metals; parts to be treated are submerged in a bath at room temperature for 7-10 min., with current density 4 amp./ft.^{2}, and 6 volts. Appearance of the finish, unpolished, is similar to Ag. High corrosion resistance up to 600°F. is claimed. Cost ranges from ⅛ to ½ cent per lb. of treated part for labor and materials. MS (8d)

Recent Experiences in the Field of Silver Electroplating (Neuere Erkenntnisse auf dem Gebiet der galvanischen Versilberung) *Oberflächentechnik*, Vol. 10, July 18, 1933, pages 165-167. According to recent experiments, attempts to replace cyanide baths, now generally used, by baths of sulphates, nitrates, fluorates and fluorides have not proved practicable as such baths do not give a fine structure as does the cyanide bath. The latter was investigated with respect to bath resistance, polarization and throwing power. Resistance depends only on the composition and temperature of the bath; it changes about 2% for each °C. The Ag content has little influence on resistance; this decreases as the free cyanide increases. Addition of soda eliminates "aging" of the bath and reduces resistance. Polarization at the anode is normal, i. e., it increases with current density and decreases with temperature; it should not exceed 0.5 volts, still better 0.2 volts. The cathodic polarization behaves in the same way but in wider limits; 0.5 volts should be the limit. Throwing power depends very much upon the cathode potential. Following electrolytes are recommended: for Na baths 25 g. Ag, 30 g. free NaCN and 45 g. soda/l., maximum polarization on both anode and cathode 0.5 volts. For K baths 25 g. Ag, 60-75 g. potash and 45 g. free KCN/l., maximum cathodic polarization 0.7 volts, anodic 0.5 volts. Very bright deposits are obtained with 1 g. sodium thiosulphate and 10 cc. 28% ammonia water/l. and 0.8 amp./dm.^{2}; the current output is almost 100% and the deposits are harder than the normal deposits. 6 references. Ha (8d)

The Electrodeposition of Platinum Metals (Neues über die elektrolytische Abscheidung von Platinmetallen) *Oberflächentechnik*, Vol. 10, Sept. 5, 1933, pages 201-202. Current output and efficiency of electrolytic deposition of Pt metals is still very low and not comparable with those for Ni, Cu, Ag with values between 90 and 100%. Solutions used are reviewed and recent improvements discussed. The method of Baker (D.R.P. 549775) uses electrolytes containing complex ammino-nitrites in which the reactions can be represented by

$$6NaNO_2 + PtCl_3 = Na_3Pt(NO_2)_6 + 3NaCl$$

$$Na_3Pt(NO_2)_6 + 6NH_4OH = [Pt(NH_3)_6](NO_2)_3 + 3NaNO_2 + 6H_2O$$

This bath operates at 70°-75°C. with a current density of 0.8-1.3 amp./dm.^{2} and produces a bright, continuous Pt deposit. This process has been improved by elimination of the halogen; other patented methods work with double nitrites. A method for Pd deposition employs a solution of 4-8 g. potassium-pallado-nitrite (obtained from potassium-palladium-chloride and potassium-nitrite) in 1 l. H_2O to which is added twice to 3 times the amount of sodium citrate. 2-4 v. and a current density of 0.5-1.5 amp./dm.^{2} are used at normal temperature. For the deposition of Rh, alkali nitrites are employed, or sodium sulphate in weakly acid solution with about 5% P_2O_5, oxalic acid or H_2SO_4 (English Patent 367588). Ha (8d)

Progress in Electrodeposition, 1933-1934. E. A. Ollard. *Metal Industry*, London, Vol. 44, Jan. 12, 1934, pages 70-72. A review; interesting developments are (a) increased use of Pd and Rh plating for ornamental purposes as well as for protection against tarnishing; (b) anodic oxidation and its testing and standardization. Ha (8d)

Anodes for Chromiumplating in Solutions Containing Hydrofluoric Acid (Anoden für die Verchromung in Flusssäure enthaltenden Lösungen) Erich Mueller & J. E. Vestdal. *Zeitschrift für Elektrochemie*, Vol. 40, Jan. 1934, pages 14-18. In order to prevent accumulation of trivalent Cr at the cathode in aqueous chromic acid solution for chromium plating and with it neutralization of the solution, Pb anodes are used. However, considerable contact resistance develops if F is present and the plating process is interrupted and started again on account of the formation of lead-fluoride on the surface. Experiments with Bi additions to Pb are described which showed that Cr is oxidized to CrO_3 at the anode as it should be in the satisfactory process without increasing the contact resistance appreciably; Pb anodes with 20-30% Sb give good practical results in chromic acid solutions containing HF. Ha (8d)

"Matte" Chromium Plating (Mattverchromung) Herbert Kurrein. *Metallwaren Industrie & Galvano Technik*, Vol. 31, Sept. 1, 1933, pages 341-343. The author designates as "Mattverchromung," a Cr plating of a surface which has been rendered "matte" or dull. This process has certain economic advantages, however objections in regard to corrosion resistance arise. Experiments by the author with sheets which had been rendered "matte" by various methods, showed that Fe was attacked more severely in the spray test in spite of heavy intermediary layers of Cu and Ni. This shortcoming however was not experienced with brass. EF (8d)

Prevention of Tarnishing of Silver or Silver Ware by Electro Deposits (Verhütung des Anlaufens von Silber oder Versilberten Waren durch galvanische Niederschläge) H. Krause. *Deutsche Goldschmiedezeitung*, Vol. 36, Dec. 16, 1933, pages 545-548. Gives a chronological survey of methods used or proposed for retarding tarnishing of Ag ware. Pd plating was proposed as far back as 1903 by Langbein, according to whom the best electrolyte is a solution of $PdCl\text{-}NH_4Cl$. Siebert-Kohlweiler (1926) used cyanalic electrolytes of Pd. Heraeus used similar electrolytes containing double nitrites of the Pd metals with Na and K, the process being carried on at room temperature. More recently Rh plating is used for mentioned purpose; Rh is harder than Pt and Pd, in reflectivity and color it is close to Ag. Various Rh electrolytes are considered, such as those described by Cinaman, Baker, Co., and others. Ir has been proposed in Metal Industry, 1931, page 245. Also Cr is used; various methods are described. However, in Cr plating piece should first be Ni plated. Results of investigations on direct Cr plating carried on by Lehr- und Versuchsanstalt für Galvanotechnik at Schwäbisch- Gmünd are discussed but are not encouraging. The protection of the base metal in Cr plating essentially depends on a sufficient Ni plating. Following process was patented by Fischbeck; metals used should be those which form S and O compounds that are not decomposed by the base metal. The layers of protective metal should be so thin that the base metal shines through the plating metal. The latest proposal for protecting Ag against tarnishing is to use In as plating metal. GN (8d)

Prevention of the Tarnishing of Silver by Electrodeposits. II. (Verhütung des Anlaufens von Silber durch galvanische Niederschläge. II.) Maka. *Deutsche Goldschmiedezeitung*, Vol. 37, Jan. 13, 1934, page 36. In supplementing Krause's paper (*Deutsche Goldschmiedezeitung*, Vol. 36, Dec. 16, 1933, pages 545-548) the author reviews results of recent investigations by Grube and Kösting on Rh plating baths, according to which bright Rh deposits are obtained from H_2SO_4, H_2SiF_6, H_2BF_6, $HClO_4$ and $C_2H_2O_4$—Rh baths, all of which can be regenerated by dissolving additional rhodium hydroxide. Chloride baths give bright deposits, but too brittle. Phosphate baths, faintly alkaline in contrast to other mentioned baths give bright and tightly adhering deposits with 0.3 amp./dm.^{2} but they cannot be regenerated by rhodium hydroxide. H_2SO_4 bath is very good at 20° C. with current density of .2-.35 amp./dm.^{2}, bright and tight deposits are obtained current efficiency 80-85%. It is quite insensitive to change of composition and is easily regenerated. Also perchlorate bath is rather independent of acid concentration. H_2SiF_6 bath gives good deposits at .4 amp./dm.^{2} with a current efficiency up to 94%. H_2BF_6 — Rh bath is less suitable and is regenerated with difficulty. GN (8d)

Use of Diaphragms in Industrial Electrodeposition of Metals (L'Emploi de Diaphragmes dans l'Electrolyse Industrielle des Métaux) M. Bogitch. *La Technique Moderne*, Vol. 25, Jan. 1, 1933, pages 31-32. Abstract from a lecture at the Académie des Sciences on Nov. 7, 1932. FR (8d)

The Application of Electrodeposition to Printing. H. E. Boughay. *Metal Industry*, London, Vol. 44, Jan. 5, 1934, pages 15-16; Feb. 2, 1934, pages 141-143. Processes of making cliches, cuts, electros, half-tone blocks, etc. used in printing and the application of metal deposits of Sn, Cu, Zn, Ni and Cr are described. Ha (8d)

Heavy Hydrogen and Heavy Water in Electroplating (Von schwerem Wasserstoff und schwerem Wasser in der Galvanotechnik) H. M. Forstner. *Oberflächentechnik*, Vol. 11, Feb. 20, 1933, pages 39-40. The newly discovered isotope 2 of H and "heavy" water can be produced most conveniently by electrolysis, and particularly by electrolysis with Ni-electrodes in NaOH solution. This led to the conclusion that possibly many of the inexplainable difficulties and failures connected with Ni-plating can be traced to the accumulation of heavy water in the electrolyte which is generally alkaline. An investigation of these conditions is suggested particularly to show to what extent the heavy isotope of H may accumulate on the cathode and cause pitting and porosity of the deposit. There can be no doubt that heavy water is accumulating in electrolytes. Ha (8d)

Denture Bases Prepared by Electrolysis. Frederick W. Frahm. *British Journal of Dental Science and Prosthetics, Prosthetics Section*, Vol. 78, Nov. 1933, pages 318-322; abstracted from *Dental Items of Interest*, Vol. 55, No. 8. The production of silver and gold denture bases by electro-deposition on plaster casts, coated with a varnish containing powdered copper, or covered with tin foil, is briefly described. JCC (8d)

Metallic Coatings Other Than Electroplating (8e)

Galvanizing Fluxes. W. H. Spowers, Jr. *Wire & Wire Products*, Vol. 8, June 1933, pages 165-167, 184. The formation of dross during hot-galvanizing, by contamination of the liquid Zn by Fe is discussed. New method was developed to eliminate dross almost entirely by using neutral flux. Material to be galvanized is dipped after pickling in very dilute aqueous solution of HCl or zinc chloride just before it enters the galvanizing kettle. A special flux containing the frothing agents (composition not given) has been developed for this process. Ha (8e)

Application and Economics of the Process of Metal Spraying. Chas. Stipp. *Welding Engineer*, Vol. 18, Mar. 1933, pages 12-14. Methods and examples of coating metals and non-metals by spraying with Zn, Sn and Al, for corrosion prevention, improvement of appearance, better heat conductivity, etc. Ha (8e)

Industrial Uses of the Metal Spraying Process. A. Van Winsen. *Iron & Steel of Canada*, Vol. 16, July-Aug. 1933, pages 91-93. Address before Montreal Chapter, A.S.S.T., dealing with Schoop's metallization process and its more recent applications. Three illustrations. OWE (8e)

Sherardizing, Calorizing, Chromium Plating (Sherardizzazione, Calorizzazione, Cromizzazione) O. Macchia. *L'Industria Meccanica*, Vol. 15, Sept. 1933, pages 676-677. Brief description of processes. 15 references. Ha (8e)

Metal Coating (La Metallisation) *Le Soudeur-Coupeur*, Vol. 12, Oct. 1933, pages 1-5. Discusses the Schoop metal spraying process. Aluminum is most suitable for spraying. RRS (8e)

Determination of the Weight of Coating on Galvanized Sheets and Wire. *Sheet Metal Industries*, Vol. 7, Aug. 1933, pages 207-208, 212. The revised standard methods of the A.S.T.M. are set forth. AWM (8e)

Metal Spraying. *Textile World*, Vol. 83, Nov. 1933, page 82. Advantages of spraying metal by compressed air in repair and maintenance work of textile mills and for decoration on textiles are discussed. Ha (8e)

Metallizing in Canada. *Iron & Steel of Canada*, Vol. 16, page 93. Brief description of recent commercial applications of metallizing in Canada by the B. W. Deane Company, Montreal. OWE (8e)

Neo-Sherardizing. Rustproofing by the Sherardizing Process. *Metal Industry*, London, Vol. 43, Dec. 29, 1933, page 630. Describes a modification of the familiar sherardizing process—heating the ware in contact with Zn powder at 600° F. in a closed receptacle—which is said to give a brighter and more uniform coating of any desired thickness. This coating can be highly polished for chromium-plating. Cu, brass or Al "sherardizing" can be applied by substituting the respective powders for Zn. Several examples are described. Ha (8e)

The Spraying of Metals. *Metal Industry*, London, Vol. 42, Mar. 3, 1933, pages 255-256. Methods and tools for spraying Zn, Al and Sn on metals are described and illustrated. Ha (8e)

Hard-Facing for Permanence. *Oxy-Acetylene Tips*, Vol. 12, Sept. 1933, page 202. Parts subject to excessive abrasive wear which had to be replaced often were rebuilt to original size by welding stellite (a non-ferrous, abrasion-resistant alloy of Co, Cr and W) on the worn surface. Examples are given. Ha (8e)

Standard Specifications for Zinc (Hot-galvanized) Coatings on Structural Steel Shapes, Plates and Bars and Their Products. *American Society for Testing Materials, A.S.T.M. Designation: A123-33; American Standards Association, A.S.A. No. G8.1-1933*, 4 pages. AHE (8e)

Homegeneous Lead Coating (Über die sog. homogene Verbleiung) F. SEEHOF. *Die Metallbörse*, Vol. 23, Sept. 2, 1933, pages 1118-1119. The writer holds that Pb coating still remains a competitor of stainless steels and special bronzes in chemical engineering and discusses critically special cases of utilization. Steel brushes, sand blasting, H_2SO_4 or HCl pickling are recommended before depositing an initial Sn layer and the final Pb coating which should not be exposed to temperatures above 150°-160°C. Twelve patents are discussed in detail dealing with firm adherence of the Pb coating to the base. The writer recommends heating the objects in liquid Pb at about 360° C. under a protecting $ZnCl_2$-NH_4Cl or borax cover analogous to galvanizing. An initially clean metallic surface of the part to be coated is essential. Pb may also be deposited with a hydrogen flame, with a paste-like flux composed of powdered NH_4Cl, water-free glycerine and solid Pb powder. The ever occurring pores are eliminated by the metal spray pistol. Data on expenses referring to German conditions are given. EF (8e)

Metallization of Synthetic Resin (Metallisieren von Kunstharz) *Kunststoffe*, Vol. 23, Oct. 1933, page 239. The tinning of surfaces in radio sets by pasting in tinfoil involves difficulties which are overcome by sandblasting and subsequent metal spraying. A coat of a celluloid lacquer is used to protect the metallic coat against soiling. EF (8e)

Tinning of Bearing Surfaces (Zum Verzinnen von Lagerschalen) E. T. RICHARDS. *Die Werkzeugmaschine*, Vol. 37, Dec. 31, 1933, pages 443-444. Since fit between bearing body and white metal bearing surface is insufficient in many cases due to different shrinkage, even when bearing body has been carefully shaped and worked, bearing body is advantageously first tinned. A tinning method is described guaranteeing tight fit between bearing body and bearing. GN (8e)

Protecting Iron and Steel From Rust and Corrosion. The Hot Galvanizing Process. *Gas Journal*, Vol. 202, May 10, 1933, page 324; *Gas World*, Vol. 98, June 3, 1933, page 621. The term "galvanizing" is usually understood to apply to the "hot" galvanizing process in which articles to be treated are immersed in a bath of molten zinc. This process is advocated in preference to electro-galvanizing. MAB (8e)

Formation of Hard Zinc (Hartzinkbildung) HEINRICH MEYER AUF DER HEYDE. *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 24, Jan. 28, 1934, page 45. The temperature which must be maintained for obtaining good Zn coatings, plays no considerable role in formation of hard Zn. Chief reason for formation is local superheating of kettle; solution of Fe in Zn reaches maximum at 495°C. No area of kettle should exceed a temperature of 475°C. GN (8e)

Metallization Method for Objects of Plastic Materials (Ein Metallisierungsverfahren für Gegenstände aus Presstoffen auf kolloidaler Basis) RENE W. P. LEONHARDT. *Kunststoffe*, Vol. 24, Mar. 1934, pages 55-56. Metal spraying is not suitable for pressed plastic materials because of the extremely smooth surface. Process to overcome this consists in applying solutions which contain both a dissolving and a reducing agent. The former causes the surface to swell and the latter penetrates the surface as a colloidal solution. After drying, the treated specimen is dipped into a reducible metal salt bath. An extremely fine and uniform metal deposit develops which often renders further electro-deposition superfluous. Areas on which metallic coating is not desired are protected by cellulose ester lacquer or asphaltic lacquer which is later removed mechanically. The great economy of the dipping process is emphasized. Solutions of 2% Au chloride or 2.5-3% Ag salts are employed. 500 cc. of the latter metallize an area of 1200-1500 $cm.^2$. A single dipping develops a metal film of about 0.001 mm. thickness which can be reinforced by further dippings. This metallization process can be applied to all materials of glue and gelatine basis, to casein, albumin, urea, thio-urea, protein and formalin condensation products. EF (8e)

Innovations in Metal Spraying (Neuerungen beim Metallspritzverfahren) R. COLELL. *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 24, Feb. 11, 1934, page 77. Briefly describes alumitizing process in which better protective action of metal sprayed is attained by alloying action between Al and base metal. Recent improvements in spraying guns are pointed out. GN (8e)

Non-Metallic Coatings (8f)

Influence of Oil Content of Paints on the Properties of the Coats (Ueber den Einfluss des Oelgehaltes von Anstrichfarben auf die Eigenschaften der Anstriche) H. WOLFF. *Oberflächentechnik*, Vol. 10, July 4, 1933, pages 156-157. The ratio of oil to pigment in a paint was derived from an empirical formula. A critical oil content was found which, even though the general rust-protecting property of the paint was not very good, did not show trace of rust on painted iron after 6 months. A deviation of only 2.5% in the oil content resulted in marked rusting. A paint having critical oil content is always rust-protective. The critical oil content differs with different pigments; it can be calculated approximately from the viscosity formula. It has a certain influence on the mechanical properties of the paint. Ha (8f)

Enamel and Enameling (Email und Emaillieren) L. VIELHABER. *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 23, Dec. 31, 1933, pages 723-724. Author deals with historical development of the enameling industry in Germany, essential characteristics of good enamels, various types of enamels, manufacturing methods with special reference to preparation of batch, suitability of various Fe and steels brands for enameling, causes of failures, enameling furnaces with special reference to electric furnaces, applications of enameled products. GN (8f)

Baked Lacquers in Sheet Metal Industry (Über Einbrennlacke für die Blechembeilagen- und Blechwaren-Industrie) FRITZ ZIMMER. *Farben Zeitung*, Vol. 38, Oct. 21, 1933, pages 1530-1531. Various surface treatments of tinplate are summarized and recent advances of securing Ag and Au lacquers between 50° and 120°C. are reviewed. An automatic coating machine and a modern automatic enameling furnace are described and illustrated. EF (8f)

Corrosion Protection of Underground Cables (Korrosionsschutz von unterirdischen Kabeln) E. SOLERI. *Elektrizitätswirtschaft*, Vol. 32, Nov. 30, 1933, page 518. Bituminous coatings should not contain phenol and the volatile fraction must be very low. For cable covering Pb with 1-3% Sn or 1% Sb is more resistant than pure Pb. Protective Pb salts are formed by utilization of pure tar containing 3% S. Pb cables should be subdivided by properly insulated joints. The potential between Pb cable and soil can be reduced to a harmless value by connecting the cable, in series with resistance, to large Fe mass such as rails. WH (8f)

Electrolytic Oxidation of Aluminum (Die elektrolytische Oxydation von Aluminium) *Oberflächentechnik*, Vol. 10, Aug. 1, 1933, pages 175-178. Review of development and present status of production of oxide film on Al, both for protection against corrosion and for ornamental purposes; in particular the different processes for anodic treatment are described. Different electrolytes and properties of coatings are discussed and many patents concerning methods in all countries enumerated. Ha (8f)

Cold Enameling of Jewelry. New Method without Application of Enameling Furnace (Kaltemaillieren von Schmuckwaren. Neues Verfahren ohne Anwendung von Emaillieröfen) *Deutsche Goldschmiedezeitung*, Vol. 37, Feb. 10, 1934, page 73. Describes a new type of enamel, used cold, characterized by resistance against acids, alkalies, heat, and most organic solvents; it possesses excellent adherence even on smooth surfaces and forms, after drying, a hard shatter-proof, tough layer. Working procedure is outlined. GN (8f)

TESTING (9)

Aeronautical Research. *Engineer*, Vol. 156, Sept. 1, 1933, pages 214-216. From a Report for the year 1932-33 of the Aeronautical Research Committee, a British publication. Research was carried out along metallurgical lines investigating thin sheet metal, torsion of metal tubes, fatigue strength of metals, welded joints, and protection of Mg alloys against corrosion. LFM (9)

Photo-Elasticity—A Short Explanation of the Optical Principles Involved. THOMAS H. EVANS. *Civil Engineering*, Vol. 3, Oct. 1933, pages 570-573. JCC (9)

Cast Iron Research Association. *Engineer*, Vol. 156, Nov. 10, 1933, pages 475-476. From the Presidential Address delivered by F. A. Freeth before the Cast Iron Research Association. LFM (9)

On a Simple Apparatus for the Determination of Melting Points, Boiling Points, Transition Points, Ignition Temperatures, etc. Specially Convenient for Use with Small Quantities of Sample. SATOSI WATANABE. *Scientific Papers Institute of Physical & Chemical Research, Tokyo*, Vol. 22, Nov. 1933, pages 264-268. (In English) A small vessel is constructed around the hot junction of 2 metals (say Cu and constantan) and the whole inserted into a metal bottle, which can be slowly heated by electrical resistance windings. Near the vessel containing the sample there is a second thermo-couple connected with an independent galvanometer. The temperature differences due to the arrest of one thermo-couple at the transition point of the sample is apparent. WH (9)

Inspection & Defects, including X-Ray Inspection (9a)

C. S. BARRETT, SECTION EDITOR

Rail Failures, Their Cause, Detection and Disposition. Report of a Committee. *Railway Engineering & Maintenance*, Vol. 29, Oct. 1933, pages 484-490. The various failures are discussed under the following classifications: battered rail ends, joint gap batter, flowing of top metal, broken bases, burned rails, split webs, clear breaks, split heads, head checks, crushed heads, compound fissures, internal transverse fissures. The remedies are dealt with according to the importance of the fracture type, some of which are illustrated. The detection of defective rails confines itself to the Sperry detector car. The repair of rails is discussed. The committee draws conclusions regarding the causes of rail failures and their elimination, and urges that rails of the same heat be laid together and a record kept of their location. The introduction of Mn steel (1.3-1.6%) resulted in better wear resistance but also in an increase in the number of horizontal and vertical split heads. WH (9a)

Boiler Failures—Cause and Remedy. *Commonwealth Engineer*, Vol. 21, Sept. 1, 1933, pages 41-43. An editorial survey of the various causes to which failures of high pressure boilers may be attributed, of the contributing factors, and of the possible remedies. It is clearly shown that some of the causes of failure arise from factors introduced in the design and manufacture and some are the result of operating conditions. Remedies urged are: (1) evolution of designs that will provide ample strength and rigidity against stresses set up by the weight of integral parts and by uneven heating and that will avoid all localization of stresses. (2) Adoption of a construction technique that will eliminate any stressing and deformation of material in course of fabrication. (3) Joining of seams by a method that will provide a junction equal in strength and rigidity to the boiler plate itself. On a boiler installation in Victoria excellent results have been obtained with the use of trisodium phosphate as an inhibitor not only of corrosion fatigue but of corrosion and scale formation. WH (9a)

The Investigation of the Mechanical Breakdown of Prime Movers and Boiler Plant. L. W. SCHUSTER. *Proceedings Institution of Mechanical Engineers*, Vol. 124, Apr. 1933, pages 337-479. Includes discussion. Does not include failures primarily caused by corrosion, casting, and other forms of internal stress or thermal stress. In determining the cause of the breakdown the engineer in addition to the metallurgical examination, should know the working conditions to which the part has been subjected and of the mishaps it may have had to encounter, methods of calculating stress and of estimating stress distribution, and methods of manufacture. Largely a discussion of the mechanical rather than metallurgical causes of failure. Many photomicrographs are used to show the effect of mechanical failures. In the discussion some attention is given to embrittlement. RHP (9a)

Materials for Tubes and Pipe Lines. Recent Experiences (Werkstoffe für Rohre und Rohrleitungen, neuere Betriebserfahrungen) RUDOLF SCHNABBE. *Maschinenschaden*, Vol. 10, 1933, pages 121-125. Reviews the difficulties which arose when alloy steels were introduced and discusses defects which are due principally to S and P segregations, wrong heat treatment, and unsuitable cold rolling in of tube ends. Comparative scaling tests with sicromal steel and open hearth steel yielded scaling losses of respectively 0.01% and 14.9%. EF (9a)

Photoelectric Instrument for Continuous Examination of Metal Strips (Lichtelektrisches Prüfgerat zur fortlaufenden Untersuchung von Metallbändern) E. BORNITZ. *Zeitschrift Verein deutscher Ingenieure*, Vol. 77, Dec. 16, 1933, page 1339. Describes an installation where the finished sheet or strip coming from the finishing stand runs first through a dark box between photocells and lamps. If the material has even very fine cracks or defects the impulse given to the photocells is sufficient to give an alarm signal. The arrangement can be used for metallic and non-metallic materials. Ha (9a)

Some Notes on Fractures. J. BLUNDELL. *Journal of the Institution of Locomotive Engineers*, Vol. 23, May-Apr. 1933, pages 270-285. Failures in locomotive parts observed during 18 months are described and illustrated. Many of these demonstrate how sudden changes in section, sharp edges in general, surface defects, or tool marks may give rise to failure. JCC (9a)

The Testing of Welds. A. H. CORBETT. *Journal of the Institution of Engineers of Australia*, Vol. 5, July 1933, pages 248-251. 26 references (mostly American). The various testing methods suggested in the fields of welding up to the present time are characterized. WH (9a)

Status and Development of Material Testing Without Destruction (Stand und Entwicklung der zerstörungsfreien Werkstoffprüfung) R. BERTHOLD. *Zeitschrift Verein deutscher Ingenieure*, Vol. 78, Feb. 10, 1934, pages 173-181. Principles, methods and equipment for radiography with gamma and X-rays are described. The structure of metallic and non-metallic materials can be determined without destruction at almost any place by portable equipment. 38 references. Ha (9a)

Radium in Engineering Practice. V. E. PULLIN. *Proceedings Institution of Mechanical Engineers*, Vol. 124, Mar. 1933, pages 305-332. Includes discussion. Bibliography of 16 references. Describes and illustrates a portable radiographic laboratory, mounted in a truck, for testing in the field. The gamma radiation from Ra salts can be used for examining metals up to 8" or more in thickness while X-rays are suitable for metals up to about 3". Gives directions for safe handling and storage of Ra, with curves indicating safe working distances for operators. Gives details of technique and includes several photographs to show the results obtained by the procedure used. RHP (9a)

Testing Steel by X-Ray Methods (Stahlprüfung mit Röntgenstrahlen) *Montanistische Rundschau*, Vol. 26, Mar. 16, 1934 (Section *Stahlbau-Technik*) page 7. Discusses briefly the present status of methods and apparatus used in testing steel by X-ray methods. BHS (9a)

X-Ray Testing of Steel. R. R. LYNN. *Iron & Coal Trades Review*, Vol. 128, Feb. 2, 1934, page 221. Equipment and costs of testing fusion-welded pipes for hydro-electric plants is described. For plates up to 1½" thick 180000 volts and 4 milliamp. are used on the X-ray tube, for lower thicknesses the voltage is regulated so as to require 1 min. exposure. A complete outfit for such work costs about $8000. Methods of intensification, films to be used, etc. are briefly discussed. Ha (9a)

Optical Inspection Instrument (Die Schau-Sonde) P. NETTMANN. *Automobiltechnische Zeitschrift*, Vol. 36, Dec. 10, 1933, page 597. A thin tube with prism arrangement and electric bulb can be introduced into long holes, bores or cavities for inspection of the condition of metal on the walls. The optical system permits views of the whole as well as small areas. Ha (9a)

Steel Castings. Being the First Report of the Steel Castings Research Committee and the Discussion Thereon. *Iron & Steel Industry & British Foundryman*, Vol. 6, June 1933, pages 303-310; *Engineering*, Vol. 135, May 19, 1933, pages 557-558. Condensed from the original report. The methods of examination of castings, the principal types of casting defects, the classification of cracks, and the porosity due to small cracks are discussed in some detail. See *Metals & Alloys*, Vol. 4, Oct. 1933, page MA 329. CHL + LFM (9a)

Some Defects in the Working of Gold Alloys (Einige Fehler bei der Verarbeitung der Legierungen des Goldes) E. RAUB. *Mitteilungen des Forschungsinstituts und Probieramts für Edelmetalle*, Vol. 7, Nov.-Dec. 1933, pages 104-108; Feb. 1934, pages 127-132. Defects which become noticeable in gold alloys during or after working or in manufacturing processes can be traced to: (1) foreign metallic impurities, (2) oxidation (formation of O-compounds) of base metals in the alloys, (3) slag-like impurities, (4) particular properties of the alloys. Of foreign metallic impurities, Bi, Pb, and Te are very harmful; even with 0.05% the Au alloy becomes brittle and cracks when rolled. P causes hot-brittleness. Base metals, e.g. Cu, Cd, Zn and Ni, when present at elevated temperatures, form compounds with O which segregate when the melt solidifies and cause defects in rolling, drawing, etc. and also when the finished article is polished. Inclusions of small particles of corundum, emery or other impurities originating sometimes in the scrap used for melting also cause defects particularly in polishing. The defects under (4) can be traced to rapid growth of crystal grains which occurs particularly if Au alloys of 18 and more carats are annealed before they have been greatly deformed (rolling, etc.); the alloys should be annealed only after they have undergone a strong deformation, otherwise cracks occur during or after working. Also internal stresses can exist which lead to tearing; sometimes these can be caused by the corroding action of perspiration, especially in alloy with low Au content, 333/1000 or less. Heating to 250-300°C. suffices mostly to equalize internal stresses. Conditions are well illustrated by photos. Ha (9a)

The National Physical Laboratory. *Engineering*, Vol. 136, Nov. 10, 1933, pages 512-513. Brief summary of the research being carried out at the Laboratory. These tests include X-ray analysis, structural effects of cold working, X-ray studies of magnet and transformer steels and examinations made on single crystals of Bi. LFM (9a)

Inspection. *Automobile Engineer*, Vol. 23, May 1933, pages 169-170. All material purchased by the Bristol Aeroplane Co., Ltd. carries the manufacturers' certificate showing approval according to the Air Ministry regulations. However, this company tests all material themselves. Sample pieces are measured, soundness is tested with a light, sharply pointed steel rod; parts to be machined are struck with a hammer and punched to discover blow holes. Sound castings are heat treated, marked, and tested for breaking strength, hardness, and fracture. If any doubt arises as to quality the specimen is sent to the laboratory for micro-examination and analysis. RHP (9a)

Exhaust Valve Failures. C. C. HODGSON. *Automobile Engineer*, Vol. 23, June 1933, pages 223-227. See "Internal Combustion Engine Exhaust Valve Failures," *Metals & Alloys*, Vol. 4, Nov. 1933, page MA 369. RHP (9a)

Quality of Metal Surfaces. JOHN GAILLARD. *American Machinist*, Vol. 76, Nov. 23, 1932, pages 1149-1152. See *Metals & Alloys*, Vol. 5, Feb. 1934, page MA 63. Ha (9a)

An Investigation of the Effects of Hydrogen and Oxygen on the Unsoundness of Copper-Nickel Alloys. N. P. ALLEN & A. C. STREET. *Engineer*, Vol. 135, Mar. 31, 1933, page 363; *Metal Industry*, London, Vol. 42, Mar. 17, 1933, page 304. See *Metals & Alloys*, Vol. 5, Jan. 1934, MA 30. LFM+Ha (9a)

Improvements in the Schlieren Method. H. G. TAYLOR & J. M. WALDRAM. *Journal of Scientific Instruments*, Vol. 10, Dec. 1933, pages 378-389. 29 references. Description of and improvements on the Schlieren method of rendering visible either colorless fluids which have a different refractive index from their surrounding medium, or variations of refractive index or thickness of transparent solids. This method finds practical application in demonstrating inhomogeneities in glass and in observing strain and flow figures (Lüders' Lines) on polished surfaces of stress pieces. RAW (9a)

Definition of Rail Failures. *Proceedings American Railway Engineering Association*, Vol. 33, 1932, pages 556, 805-806. Appendix A to the Report of Committee IV on Rails. Includes discussion. Failures previously classed as "Horizontal Fissures" will in future be termed "Horizontal Split Heads." JCC (9a)

Handbook for Purchase and Acceptance of Metals and Alloys (Hilfsbuch für Einkauf und Abnahme Metallischer Werkstoffe) ERNST POHL. VDI Verlag, Berlin, 1933. Cloth, 6 x 8¼ inches, 143 pages. The preface states that this book was intended for the practical man for use in those plants where there is no materials specialist and which do not have their own laboratories.

More space is devoted to iron and steel than to the non-ferrous metals due to the more extensive use of the former. The author places considerable importance on the weldability of the material and the testing of weld seams.

The book is especially valuable as a reference book. The extensive subject index permits finding the desired points with ease.

The main sections of the book are entitled: General considerations on the testing of metals; purchase, testing and acceptance of iron and steel; of copper and its alloys; of aluminum and its alloys; of magnesium alloys; of lead; of tin; of zinc; of nickel and its alloys.

The book will be invaluable to inspectors and purchasing engineers.

Richard Rimbach (9a)-B-

Cracking in Diesel Engine Piston-rods. W. S. BURNS. *Mechanical World & Engineering Record*, Vol. 93, May 19, 1933, pages 479-480. Rods of carefully forged 3% Ni steel, heat-treated to give 50 tons tensile strength failed. Examination showed the cause to be creeping cracks starting from the cooling water holes. Signs of corrosion could be observed especially at the section of maximum stress concentration. Change of material for the rod was of no avail and the trouble could be considered cured after the cooling medium was changed to oil. Kz (9a)

Grave Faults in the Goldsmith Shop (Kardinalfehler in der Goldschmiedewerkstatt) *Deutsche Goldschmiedezeitung*, Vol. 36, Aug. 12, 1933, pages 341-342. Following is covered: Errors made in separating precious metals, in melting separated metals with special reference to Pt and Au, failures due to incorrect treatment of metals to be used for enameling parts, careless treatment of sheet rolls and drawing dies, wrong shaping and other working processes applied in goldsmith shops. GN (9a)

Measuring Wear of Rails and Fishplates. J. D. W. Ball. *The Railway Engineer,* Nov. 1933, pages 346-347. A simple arrangement suited for measuring the wear of rails at fishplated joints and subsequent evaluation in the drawing office is described. The efforts of tightening up bolts of worn fish-plates is discussed critically and the utilization of new fish-plates, at least 1/16 of an in. full to gage as compared with the standard section, and with an upward set of the same amount in the middle is urged. By adopting this type of fish-plate, worn track can be reconditioned at insignificant cost compared with that of cutting off the ends of the rails and drilling. WHp (9a)

New Method of Angular Photographs for X-Ray Examinations of Welded Joints (Neuartiges Verfahren für Winkelaufnahmen bei Roentgenuntersuchungen an Schweissverbindungen) W. Grimm & F. Wulff. *Autogene Metallbearbeitung,* Vol. 26, Apr. 15, 1933, pages 120-123. Defects in welded joints can be more readily detected if an X-ray exposure is made in the direction of the edges of the V or X of the joint. An arrangement for turning the piece (if small enough) or the camera and source of X-rays at the proper angle is described; it is even possible to make stereoscopic pictures in this manner. The evaluation of the pictures is explained and illustrated by several examples. Hap (9a)

An Improved Means of Studying Plate Embrittlement. J. P. Morrison. *Locomotive,* Vol. 39, Apr. 1933, pages 162-166. A rivet hole magniscope is described, an instrument having a magnifying microscope or periscope and which can be fastened in a rivet hole or other convenient aperture in a boiler to inspect the walls of rivet holes or the seams for any caustic embrittlement that might have developed. A camera is attached to photograph the inspected area and discover cracks or similar defects. Application is described and some photographs reproduced. Hap (9a)

Control Testing of Metallic Castings. R. B. Mears. *Metal Industry,* London, Vol. 43, Nov. 24, 1933, pages 517-518; Dec. 8, 1933, pages 565-566. Methods of testing castings for porosity, hardness, wear resistance, adherence, impurities and their distribution are reviewed and 44 references cited. Hap (9a)

X-Ray Examination for Metal Defects. Lester E. Abbott. *Bell Laboratories Record,* Vol. 12, No. 3, Nov. 1933, pages 72-76. Describes essentials of set-up, outlines method and precautions, gives illustrations of examinations of castings, welds and assemblies. MFBp (9a)

Measurement of Stresses by Means of X-Rays (Ueber die Messungen von Spannungen durch Röntgenstrahlen) H. Moeller. *Zeitschrift für technische Physik,* Vol. 14, No. 6, 1933, pages 217-220. A discussion of the accuracy that may be obtained in X-ray measurement of homogeneous stresses when back reflection cameras are used. Using gold as a calibration substance, the lattice constant of iron is measured to ± .0001 A.U. by a single film; and to ± .00001 A.U. by averaging a number of films. CSB (9a)

Measurement of Surface Coarseness (Metod at bestämma en ytas groplghet, resp. skrovlighet) C. Benedicks & P. Sederholm. *Jernkontorets Annaler,* Vol. 117, Mar. 1933, pages 143-151. An Al sheet is clamped against the surface to give a negative impression. A positive impression is obtained from this on a celluloid plate by heating to 125° C. for 30 min. at 20 kg./cm.². A drop of standardized $FeCl_3$ dissolved in glycerin is placed on the surface of the positive and excess water squeezed out under a glass plate of the same diameter. By determining colorimetrically the amount of liquid remaining in the surface depressions, the average depth of the depressions may be calculated. HCD (9a)

Concentration of Stress around Spherical and Cylindrical Inclusions and Flaws. J. N. Goodier. *Transactions American Society of Mechanical Engineers,* Applied Mechanics Section, Vol. 55, Apr.-June 1933, pages 39-44. Solutions of the equation of elasticity are applied to investigate the disturbing effect of small spherical and cylindrical inclusions in an otherwise uniform stress distribution; numerical results are derived for a few cases. 13 references. Ha (9a)

Magnetism and the Structure of Metals. Francis Bitter. *Mechanical Engineering,* Vol. 55, May 1933, pages 287-289, 336. By using fine magnetic powder it has been found possible to detect mechanical flaws and imperfections and even structural characteristics otherwise not detectable. Photographs of the alignment of the powder show for instance grain structure of Fe-Si alloy or slip lines and grain boundaries and certain characteristic lines in monocrystals of Ni and Fe where the Fe filings deposit in a magnetic field surrounding the crystal. Theories trying to explain the electron behavior in crystals are briefly discussed. Ha (9a)

Development of X-Ray Tube and Its Significance to Science and Industry (Die Entwicklung der Röntgenrohre in ihrer Bedeutung für Wissenschaft und Technik) Walther Gerlach. *Die Chemie Fabrik,* Vol. 6, Oct. 11, 1933, pages 419-426. The original X-ray tube of Röntgen is described and its development to the modern tube traced. X-ray tubes for the determination of macro-structure, atomic structure, chemical analysis, and the construction of metallic tubes are described. The shortcomings of the present tubes and the need for future development are discussed. CEM (9a)

X-Ray Evidence of Interior Corrosion in Wire Cables (Röntgennachweis der inneren Korrosion von Drahtseilen) R. Glocker, P. Wiest & R. Woernle. *Stahl und Eisen,* Vol. 53, July 20, 1933, pages 758-761. Wire cables with a hemp core showed interior rusting in the spaces between the braided strands which could be detected by X-ray radiographs as a partial filling up of the spaces. The radiographs also indicated the outer wires of the braids to be lifted slightly by the inner wires; this could not be detected by ordinary inspection. Details are given of the X-ray technique used. SE (9a)

Gamma Ray Radiographic Testing. Gilbert E. Doan. *Journal of the Franklin Institute,* Vol. 216, Aug. 1933, pages 182-216; Sept. 1933, pages 351-384. The writer gives a narrative sketch of the development of γ-rays for radiographic testing in excellent text-book style. 23 references. DTR (9a)

Optical Tools for Inspection and Testing. C. F. Smith. *Machinery,* London, Vol. 41, Nov. 24, 1932, pages 209-212; Dec. 15, 1932, pages 309-312. 2 illustrated articles describe angle dekkor and various applications. Kz (9a)

Scheme for Gage Checking of Working and Inspection Gages During Their Manufacture. A. C. Kutai & G. A. Steuermer. *Stanki I Instrument,* No. 7, July 1932, pages 23-26. (In Russian.) Instead of lapping the gages to the size of a standard during their manufacture it is better to grade them according to tolerance limits. Three schemes of gage set-up are proposed to simplify this operation. (9a)

A Crack Sleuth. Magnetic Powder Inspects Turbine Blading. F. C. Jacobs. *Power,* Vol. 77, May 1933, pages 238-239. Turbine spindle is magnetized, and a tinted magnetic powder sprinkled over the blades. Surface cracks as small as 0.005" deep can be detected easily. AHE (9a)

Mill Inspection by Deep Etch. C. V. Luerssen. *Metal Progress,* Vol. 22, Oct. 1932, pages 39-41. Abstract of a paper for the Buffalo Convention, A.S.S.T., Oct. 1932. The etch testing of billet ends at the mill to improve melting practice and prevent the shipment of defective material is described. The advantages, preparation, cutting and etching of billets is recounted. The inspection is a matter of judgment as etching magnifies certain defects. The degree of the defects, type of steel and ingot characteristics must be considered in approving, rejecting or cropping back a billet. WLC (9a)

X-Ray Inspection in the Shop. (Röntgenuntersuchungen in der Werkstatt.) P. Wiest. *Werkstattstechnik,* Vol. 26, July 15, 1932, pages 281-282. Describes apparatus for everyday use and its application in various cases of production control on ferrous and non-ferrous metals. RFV (9a)

Devices that Gage Work in the Machine. O. P. van Steewen. *American Machinist,* Vol. 76, May 19, 1932, pages 642-644. Describes gaging methods and appliances for precision measurements without interruption of operation in the machine tool. Ha (9a)

Sheet Metal Gages and Standardization. *Machinery,* London, Vol. 41, Feb. 23, 1933, pages 617-619. With the increasing popularity of press work and the general utilization of sheet and strip metals, arise problems in the fixing of thickness tolerances and the selection of gages. Review of gage systems and proposals. Kz (9a)

Chemical-Metallographic Detection of Wrought Iron (Chemisch-metallographischer Nachweis des Schweisseisens) *Die Wärme,* Vol. 56, Apr. 15, 1933, page 236. Unetched and etched micro-structures of chips taken from an old boiler confirmed the chemical analysis (0.05% C, 0.13% Mn, 0.33% P) that wrought iron high in P and not mild steel had been employed. EF (9a)

Bridge Testing by the Measuring Vans of the German State Railway. B. Bernhard. *Railway Engineer,* Vol. 53, May 1932, pages 184-185. A paper read before British Section of Société des Ingénieurs Civils de France, Feb. 23, 1932, describes 2 vans. No. 1 is mainly employed for static and dynamic tests. Van No. 2 serves principally for X-ray photography of welded and riveted joints and in exceptional cases also for reinforced construction. WH (9a)

File Test Rapid But Limited to Very Hard Steels. H. T. Morton. *Metal Progress,* Vol. 23, Feb. 1933, page 45. The file test has been retained at the Hoover Steel Ball Co. regardless of the installation of modern indentation hardness equipment because of its simplicity and rapidity. Parts should be clamped rigidly, enabling the tester to use both hands and control pressure. Filing speed is very important. Fast filing wore away a ball of C-64 Rockwell where slow heavy filing was without effect. Ordinary parts of C-62 to 64 will not be cut, while C-58 cuts slowly. Cr steel parts, drawn at 350° F., of C 62-64 will often cut easily. The test depends on standardization of files, speed, pressure and angle of filing. A slow speed is more accurate than high speed. Usefulness is limited to a min. of C-58 to 60. Cost depends more on the life of the files than on labor costs. Skilled workmen obtain the longest file life. WLC (9a)

Inspection of High-Grade Gray Cast Iron Castings (Erfahrungen bei der Abnahme von hochwertigem Grauguss) Krüger. *Die Wärme,* Vol. 55, Sept. 24, 1932, pages 671-676. Experiences gained on the inspection of gray cast iron objects is exhaustively treated from the following view-points: (1) inspection and checking wall thickness, (2) water pressure tests and (3) testing of physical properties. The fourth chapter presents data collected during the course of several years. A wider range and more irregular results of bending values were observed with shorter test bars and a gradual improvement of the quality of cast iron was distinctly noticed. Tensile tests also carried out on a large scale yielded fewer fluctuating results than bending tests. The various graphite occurrences are discussed. Diagrams are presented showing bending test results according to Meyersberg's method (*Kruppsche Monatshefte,* Vol. 12, Dec. 1931, pages 301-330) which yielded definite clues in regard to the varying data of bending tests. The application of the Brinell hardness testing method to cast iron is critically discussed. EF (9a)

Development and Application of Macro-etching. H. G. Keshian. *Heat Treating & Forging,* Vol. 18, Nov. 1932, pages 645-646, 664; *Transactions American Society for Steel Treating,* Vol. 21, Apr. 1933, pages 289-309. Paper presented at Buffalo Convention, *American Society for Steel Treating,* Oct. 1932. Development of etching test for steel is recounted. Advantages and defects of macroetching are discussed. 12 macrographs illustrating porosity, segregation and dendritic structure brought out by macroetching are shown. Standard conditions for testing and standards of acceptance or rejection are recommended for the more profitable use of this test. Bibliography appended. Includes discussion. 8 references. MS + WLC (9a)

Essential Factors in Conducting the Macroetching Test Under Usual Practical Conductions of Production Work. Michael G. Yatsevitch. *Transactions American Society for Steel Treating,* Vol. 21, Apr. 1933, pages 310-342. Paper presented before Buffalo Convention, Oct. 1932. Factors affecting macroetching results are given. Experiments carried out at Watertown Arsenal toward a standard practice are described. An etching reagent composed of 38 parts HCl, 12 parts H_2SO_4 and 50 parts H_2O is recommended for best all around results. Etching time is a vital factor in this work. Data on 9 kinds of steel giving loss in weight for 15-60 min. etching time is presented to show that the etching time must be accomodated to nature of steel. Quantity of reagent required/in.² is shown in a table. Graphs of loss of weight versus time and loss of weight versus temperature are shown for the 9 steels tested. Etching procedure is described in detail. Citric acid as a rust remover and for developing a special pattern is suggested. Includes discussion. WLC (9a)

Pipes in Metal Castings. (Lunker im Metallguss.) *Zeitschrift für die gesamte Giessereipraxis,* Vol. 54, July 23, 1933, pages 307-308; Aug. 6, 1933, pages 329-330. The coefficients of linear and volumetric shrinkage give no sufficient explanation for piping. The specific volume in liquid and solid state give a better explanation. The following table shows the volume changes of a few alloys in solid and liquid state. According to this table the alloys can be classified in 2 groups, the one comprising those having a minor shrinkage in liquid state, the other those with 50 and more % shrinkage in liquid state.

Metal	Percent of total volume change in liquid state	in solid state
Sn bronze (8% Sn)	45.5%	54.5%
Al bronze (8% Al)	26.0%	74.0%
Al	33.0%	67.0%
Cu	32.3%	67.7%
92% Al, 8% Cu	56.0%	44.0%
Steel	25.0%	75.0%
Quality steel	50.0%	50.0%
Cast iron	50.0%	50.0%

Metals and alloys showing large shrinkage in solid state tend more to piping than the others. Non-uniform solidification of the individual parts of castings is the principal reason for piping. Piping may be aggravated in certain alloys by occluded gases. Table shows the effect of various gases on the extent of pipe formation, proving the detrimental effect of H. To obtain sound castings rather uniform cooling should be aimed at in all parts of the casting. GN (9a)

Reliability of Oil Tempered vs. Cold Drawn Wire. A. T. Adam. *Metal Progress,* Vol. 23, Jan. 1933, pages 46-47. The failure of the heat treated wire first used on the Mt. Hope bridge is referred to. The writer suggests that locked up stresses accompanied by submicroscopic cracks when subjected to the additional stress set up in bending the wire around the shoe anchorage resulted in a condition of triple stress causing rupture. The writer's experience is that better results are obtained with hard drawn patented steel wire than with oil quenched and tempered wire, particularly with C steels. WLC (9a)

Physical & Mechanical Testing (9b)

W. A. TUCKER, SECTION EDITOR

A New Method to Determine Humidity of Sands (Un nouveau Procédé pour déterminer l'Humidité des Sables) *Revue de Fonderie Moderne,* Vol. 27, Sept. 25, 1933, pages 259-260. A certain amount of the sand to be tested is placed together with some CaC_2 in an autoclave. CaC_2 and the water in the sand form acetylene according to: $2H_2O + CaC_2 = C_2H_2 + Ca(OH)_2$. A manometer shows the amount of C_2H_2 formed which is proportional to the humidity in the sand. Ha (9b)

Testing Methods for Cast Irons. (Les Méthodes d'Essais des Fontes. Travaux Effectués par l'A.T.F.B. suivant le Programme de M. Meyersberg) *La Fonderie Belge,* Vol. 2, Dec. 1932, pages 228-238. Paper read before the World Foundry Congress—Paris 1932. Results of tests are given in 12 tables. FR (9b)

Improved Apparatus for Static Determination of the Torsional Modulus of Crystal Rods and Its Application to Single Crystals of Zinc (Über eine verbesserte Apparatur zur statischen Bestimmung des Drillungsmoduls von Kristallstäben und ihre Anwendung auf Zink-Einkristalle) E. GOENS. *Wissenschaftliche Abhandlungen der Physikalische-Technischen Reichsanstalt, Berlin,* Vol. 16, No. 1, 1933, pages 69-85. The rigid clamping of the test rod is abolished in the new apparatus by a cardan suspension so that free bending of the test rods is assured during the torsional stressing. Former experiments of Goens & Grüneisen (*Zeitschrift für Physik,* Vol. 26, 1924, page 235) on single crystals of Zn were repeated yielding results which are in better agreement with theoretical isotropic properties but not with experimental determination of Bridgman. (*Proceedings of the American Academy of Science,* Vol. 60, 1925, page 305.) EF (9b)

Theory of Tough-Plastic Materials (Zur Theorie der zähplastische Stoffe) HANS FROMM. *Zeitschrift für angewandte Mathematik und Mechanik,* Vol. 13, Dec. 1933, pages 427-430. Paper before the General Meeting of the Gesellschaft für angewandte Mathematik und Mechanik, Würzburg, 1933. Many of the apparently solid materials are in reality liquids of extreme viscosity which begin to creep under considerable loads. Regarding metals, the question has not been answered yet whether they are really "liquids" or whether they become plastic on reaching a definite yield point larger than 0. In the theory of plasticity the latter assumption is being made in addition to an assumption which restricts the condition of flow, i.e. that the stresses stay within the limit of flow during the plastic deformation. The speaker points out when this mathematical simplification may be applied. Calculations on mild steel are set forth. WH (9b)

Method for Showing detailed Hardness Variations in a Test Piece (En metod att i detalj tydliggöra hardhetsvariationer pa ett provstycke) C. BENEDICKS & C. F. METS. *Jernkontorets Annaler,* Vol. 118, Jan. 1934, pages 4-22. The method consists in scratching a series of parallel lines on the test piece by means of a diamond point set in a dividing engine. When the scratches widen out a soft area is indicated. Absolute values of hardness cannot be obtained, but the method is very useful for showing non-uniformities in hardness normals and for controlling hardness. The method is highly sensitive even in case of very slight cold working. HCD (9b)

A Note on the Effect of Span on the Results of the Transverse Test of Cast Iron. J. T. MACKENZIE. *Transactions & Bulletin, American Foundrymen's Association,* Vol. 4, Oct. 1933, pages 7-11. To determine the effect of span on the results of the transverse test, cast iron bars (2 9/16" diam. machined to 2.20" diam. and 5 ft. long) were tested from three different mixtures using 8", 12", 18", 24", 36", and 48" spans. The flexural behavior of the cast iron was studied on a 3-screw Universal Riehle testing machine of 200,000 lbs. capacity. The deflections are believed confidently to be measured within 0.002" and the loads within 1% of the actual values. Results are expressed as modulus of rupture and modulus of elasticity. Curves show that modulus of rupture climbed slowly from a span of approximately 22 down to 6 diameters and then increased rapidly. Modulus of elasticity was practically the same down to 8 diameters then falling rapidly. CEJ (9b)

Application of the Pendulum for Measuring Hardness, Rigidity of Structures and Modulus of Elasticity (Application du Pendule à la Mesure de la Dureté, de la Rigidité des Constructions et du Module d'Élasticité) P. LE ROLLAND. *Usine,* Vol. 43, Feb. 22, 1934, page 29. The principle of the measurement is that the oscillations of a pendulum are faster when the pendulum rests on a cylinder and on a solid plate than on an edge. By comparing the time of oscillation of a pendulum resting on the material to be investigated with a standard pendulum on a plate of known hardness the hardness of the sample can be determined. The softer the material the faster the oscillations. In a similar way the elasticity modulus is measured by isochronism; a second identical pendulum is put in motion by the first by the exchange of energy between them through the common support; the rigidity is determined by the formula $K=\frac{4^2Mt}{T^2}$, where K is rigidity (= force/deflection), M the mass of the pendulums and T their frequency; t is the time. Accuracy of the method is said to be 1/500. Ha (9b)

Influence of Longitudinal Drilling on the Properties of Heat-Treated Steel Cylinders (Ueber den Einfluss von Längsbohrungen auf die Eigenspannungen wärmebehandelter Stahlzylinder) S. FUCHS. *Mitteilungen aus dem Forschungsinstitut Vereinigte Stahlwerke Aktiengesellschaft, Dortmund,* Vol. 3, No. 8, 1933, pages 199-243; *Doctors Thesis, Technische Hochschule Braunschweig,* 1933, 36 pages. Distribution of stresses in hollow shafts was investigated as dependent on heat-treatment. Longitudinal bores reduce local temperature differences occurring under cooling; cooling is accelerated by longitudinal bores, this causes compressive stresses at the edges of the bore and on the exterior surface and tensile stresses in the intermediary zones. The favorable influence of interior cooling on the distribution of heat stresses becomes noticeable only at a definite minimum ratio of section of bore to total section. Stresses caused by hardening behave in general as stresses due to heat-treatment. Longitudinal bores increase the uniformity of hardening in the piece, the range of "shell-hardening" shifts to lower C contents. Hollow cylinders of weakly hardening steels (C about 0.3%) can have the same hardness stresses as solid cylinders if the former show shell-hardening while the latter have still a uniform interior structure. Tempering effects in hollow cylinders reduce hardness stresses as in solid cylinders which are practically free of stresses after being heated to 300°. 12 references; results are compiled in tables and numerous charts. GN+Ha (9b)

Permanent Set in Certain Cast Non-Ferrous Alloys and Austenitic Cast Irons. J. E. HURST. *Engineering,* Vol. 136, Oct. 20, 1933, pages 429-431. Test rings were subjected to a load equivalent to a stress value of 2240 lb./in.^{2} applied along a diameter at right angles to the gap. The extension or opening of the gap is regarded as permanent set and is expressed as a percentage of the total increment of gap under the applied stress. The amount of permanent set in a series of plain Cu-Al bronzes of from 10.4 to 10.9% Al content cast by the centrifugal process varied from 6.2% to 23.2%. Monel metal rings, cast centrifugally showed a permanent set of 4.9% and showed no signs of internal stress. With the light Al alloys, the Al-Si alloys containing 88% Al and 12% Si, and the Al-Cu alloys containing 88% Al and 12% Cu or 90% Al and 10% Cu, take up very substantial permanent set at quite low stress values. An alloy containing 84% Al, 3% Cu and 13% Zn shows less permanent set than others. Tests were also made on some austenitic cast irons of the Ni-Resist type both before and after heat treatment. Tables and curves show the results of all these tests. LFM (9b)

Hydraulic Testing and Rivet Hole Cracks (Wasserdruckprobe und Nietlochrisse) E. HELFRICH. *Die Wärme,* Vol. 56, Sept. 30, 1933, pages 633-639. Critically discusses the widely adopted assumption that rivet hole cracks are due to hydraulic testing of pressure vessels. Arrives at the conclusion that this is actually not the case. The "stress peaks values" noted at the unprotected hole edges of members under strain are not present around rivet holes to the same extent. The location of the occurring rivet hole cracks with reference to the stresses produced in the boiler by water pressure tests, the type and shape of these cracks, as well as the location of defective regions on the boiler do not indicate a connection with the hydraulic testing method. Author points out that stresses and deformations prevailing during riveting promote the development of rivet hole cracks. However there must be a further contributing factor. Local stresses or selective corrosive action of weak lye solutions are suggested. The conclusions supported by 16 illustrations are based on riveted joints which failed in service. EF (9b)

Stress Concentration Produced by Holes and Notches. A. M. Wahl & R. Beeuwkes. *Product Engineering,* Vol. 5, Mar. 1934, pages 92-94. Photoelastic tests and strain measurements are described which make possible a more accurate determination of the stress concentration by a new extrapolation method. An empirical formula for the stress concentration factor, that is the ratio of the maximum stress to the average stress in the minimum section is developed 1
from the test. Ha (9b)

On the High-Speed Kinematography of Photo-Elasticity II. Ziro Tuzi. *Bulletin Institute of Physical & Chemical Research, Tokyo,* Vol. 12, Nov. 1933, pages 909-918. In Japanese. *Abstracts Bulletin Institute of Physical & Chemical Research, Tokyo,* Vol. 22, Nov. 1933, page 13. In English. A rotating camera suited for analyzing quick variations of internal stresses due to dynamic loads has been developed. It operates at a spherical speed of 22.5 m./sec. and 1/45,000 sec. exposure. Although experimental results on phenolite beams verified the generally accepted formula for dynamic stress, some systematic errors in the formula are suggested. WH (9b)

The Question of Testing Cast Iron (Zur Frage der Prüfung von Gusseisen) 2
E. Siebel & M. Pfender. *Die Giesserei,* Vol. 21, Jan. 19, 1934, pages 21-27. The characterization of mechanical properties of cast Fe was based by Meyersberg on tensile strength and bending test; this was investigated with respect to relation between elongation, bending number, ultimate strength and elongation at fracture. It is shown that a standardization of types of cast iron can be based on tensile strength and elongation at fracture for which the minimum values should be determined separately. A method for calculating the elongation at fracture is given and limiting values for tensile strength and elongation suggested for different classes of cast iron. Ha (9b)

On the Effect of Small Cavities and Cracks in a Cylinder Twisted by Torsional and Shearing Stresses (Über die Wirkung kleiner Hohlräume und Risse in einem durch Torsion und Schub beanspruchten Zylinder) 3
Bibhuti Bhusan Sen. *Zeitschrift für angewandte Mathematik und Mechanik,* Vol. 13, Oct. 1933, pages 374-379. It is known that the presence of small flaws in a body considerably diminishes its strength. Love has shown that when there is a distribution of shearing strain in a large body, the shear in the neighborhood of a small spherical cavity may be twice as great as that at a distance. The effect of a small spherical cavity in a body under uniform tension has been considered by Southwell & Gough. (Philosophical Magazine Ser. 7, Vol. 1). They found that the fracture of spiral nature, very often found in cylindrical shafts is caused by fluctuating torsional stresses and begins at a position where there is intense concentration of stress due to flow. When there is a cylindrical cavity of circular or elliptical 4
section with its axis parallel to the shaft axis, it has been shown by Larmon (Philosophical Magazine, Ser. 5, Vol. 33) that the shear in the neighborhood of the groove may be nearly twice the maximum shear that would exist if there were no groove. In the present paper the stresses in a cylinder twisted by terminal couples have been calculated, the shaft having a small spherical or spheroidal cavity on the axis or a linear flaw extending from end to end along the axis. Besides this the effect of a cylindrical flaw with elliptic section when the body has a plane distribution of shear at a great distance has been studied. WH (9b)

Research on Steels for High Temperatures. *Engineer,* Vol. 156, Dec. 1, 1933, pages 542-543. Contains statements made at a conference held relative to the research carried out at the National Physical Laboratory under the auspices of the 5
British Electrical and Allied Industries Research Association and the National Federation of Iron and Steel Manufacturers. The speakers were: Sir J. A. Ewing, H. L. Guy, A. J. Grant, Sir Robert Dixon, W. Rosenhain and Sir William Larke. These men representing various organizations comment on the value of the research to their particular industry. See also editorial on page 549 and a statement of the present position of the research given on page 554 of the Dec. 1, 1933 issue of *Engineer.* LFM (9b)

Research on Cast Iron. *Engineering,* Vol. 136, Dec. 8, 1933, pages 635-636. Brief summary of the progress being made by the British Cast Iron Research Association as shown in the Association's annual report. LFM (9b)

Transverse Tests on Sand-cast Aluminium Alloy Bars. C. E. Phillips & J. D. 6
Grogan. *Journal Institute of Metals,* Vol. 54, 1934, 10 pages (Advance copy). Samples of different ductility were made from several Al-rich alloys. Transverse tests were made on 1-in. diameter bars with as-cast surface and on ⅝-in. diameter bars with machined surfaces. Tensile tests were made on all alloys. In both transverse and tensile tests accurate stress-deformation data were obtained. The results indicated that the transverse test did not yield any information that could not be obtained as readily by the tensile test. JLG (9b)

Calculation of the Elongation in Tensile Samples with Relatively Long Gage Lengths (Berechnung der Bruchdehnung einschnürender metallischer Werkstoffe für beliebig grosse Messlängen) A. Krisch & W. Kuntze. *Archiv für das* 7
Eisenhüttenwesen, Vol. 7, Nov. 1933, pages 305-309. A formula is derived for determining the effect of increasing gage length on the percentage elongation of tested tensile samples. For a ratio of gage length to thickness of less than four, the elongation value obtained is, of course, greatly affected by the gage length, the elongation being greater the smaller the gage length. Beyond a ratio of four the effect of varying gage length is smaller, but it does not become negligible until a ratio of gage length to thickness of about ten is reached. No difference in this respect was found between round and rectangular specimens. In sheet samples the ratio is usually so high that the effect of gage length on elongation is nil. SE (9b)

Streamline Tubing Sections. *Aviation,* Vol. 32, Oct. 1933, page 317. 3 possible methods of determining actual properties of commercial aeronautical tubing 8
for use in design are the following: (1) laboratory tests on samples; (2) mechanical or long hand integration from carefully made drawings; (3) development and use of approximate formulae. R. L. Templin of the Aluminum Company of America and E. C. Hartman of the Aluminum Research Laboratories studied the 3 methods and concluded that approximate formulae could be developed and be applied satisfactorily for all practical purposes. Formulae given. DTR (9b)

International Committee for the Testing Methods of Cast Iron (Commission Internationale des Méthodes d'Essai des Fontes) *La Fonderie Belge,* Vol. 2, Dec. 1932, pages 248-250. Official report of the meeting of Sept. 16, 1932 during the world foundry congress of Paris. Committee points out necessity of continuing parallel study of the two following points which were defined at the first congress 9
of Paris: (1) Qualification of castings by means of test bars cut in castings themselves, these test bars being indispensable for examination and study of homogeneity. (2) Qualification of molten cast Fe by means of test-bars cast separately, these test bars being used in foundries for controlling fabrication. Furthermore for each problem, it is necessary to previously define best kind and conditions of test to be adopted. The two following decisions were adopted: (1) In each country an inventory will be made, by national committee, of conditions of reception of castings and the whole will be published in a booklet or international publication printed by Foundry Association in each country. (2) All publications dealing with cast Fe testing published each year will be gathered in each country by national committee who will make list of them. All lists will be collected in order to form an annual international documentation. FR (9b)

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Fillet Profiles for Constant Stress. R. V. Baud. *Product Engineering,* Vol. 5, Apr. 1934, pages 133-134. Practical designs of fillets that will give greatest economy of material and avoid concentrated stresses are explained; a theoretical method of calculation is checked by photoelastic tests. Radius of fillet is determined by type of machining process. Ha (9b)

Fatigue Testing (9c)

The abstracts appearing under this heading are prepared in co-operation with the A.S.T.M. Research Committee on Fatigue of Metals.

H. F. MOORE, SECTION EDITOR

Endurance Properties of Metallic Materials (Wechselfestigkeit metallischer Werkstoffe) W. Herold. Julius Springer Verlag, Berlin, 1934. Cloth, 6½ x 9½ inches, 276 pages. Price 24 RM. The book covers in general the same field as the earlier books of Moore and Kommers, and of Gough. It is less satisfactory than either of those in giving a clear picture of the field, but it includes recent data from German work, especially a large amount on stress distribution around notches. Work on damping is also summarized but it is not made very clear what relation this has to the endurance problem. Some accelerated methods depending on damping are discussed and evaluated as chiefly useful for sighting shots. According to the German custom, creep at elevated temperatures is included under the general heading of endurance. This section is neither complete nor very enlightening. Most of the discussion on endurance leads to the conventional conclusions. An exception is that on an eutectoid steel, originally of lamellar pearlitic structure subjected to 132 million cycles, in a dozen steps at increasing loads at 30,000 cycles/min. in a high speed machine. When the bar finally broke the structure was clearly spheroidized. The bar had to be strongly cooled by an oil stream to keep the temperature down. Though the temperature of the specimen was not determined and the change in structure must be due both to elevated temperature and repeated stress, it is ascribed by Herold to the latter. Some attention is paid to endurance of welded and riveted specimens. The spelling of English names and words is often fantastic, the outstanding case being Googh for Gough. The book is of interest as a compact summary of recent German work. Little of the recent work published in English is included and the older work seems not to have been carefully studied in the original. Few English speaking metallurgists will find the book worth the price. H. W. Gillett (9c)-B-

A Flat Bend Endurance Testing Machine of the D L V and Results Obtained With It (Eine Planbiege-Dauerprüfmaschine der D L V und die damit erhaltenen Versuchsergebnisse) Kurt Matthaes. *Metallwirtschaft,* Vol. 12, Aug. 25, 1933, pages 485-489. An apparatus is described in detail in which test pieces of sheet or strip material, profiles, or tubes are bent back and forth to determine their endurance limit in bending. The bending stress is measured by means of a spring and can be varied. Two sizes are made with bending moments up to 1600 and 150 cmkg. Static tensile and endurance bending test results on 40 samples in various conditions are given. Samples tested in their original form have much lower endurance limits and ratios of endurance limit to tensile strength than test bars machined from the original material or polished materials. Heat treated steel has a much higher endurance limit if the decarbonized surface is removed, even if it is extremely thin. Tubes with drilled holes and welded tubes had lower endurance limits and ratios than the original tubes. Corrosion such as produced by the salt spray, also lowered the endurance limit, except in two grades of stainless steels. Sheet Cu, which had been recrystallized after severe cold working, was tested in various directions with respect to rolling direction. The highest endurance limit was obtained at 45°, the lowest at 15°. Tests of this kind on materials of small cross section would be impossible to make on endurance testers with rotating test pieces. CEMp (9c)

Magnetic Testing (9d)

L. REID, SECTION EDITOR

Some Recent Developments in Electromagnetic Inspection and Test Equipments. B. M. Smith. *General Electric Review,* Vol. 36, Aug. 1933, pages 368-370. Non-destructive test and inspection equipment for examining brazed Cu tubes, welded steel tubes, etc. are described and their operation discussed. CRJ (9d)

New Methods of Non-Destructive Testing of Welds (Neue Verfahren der zerstörungsfreien Schweissnahtprüfung) *Die Naturwissenschaften,* Vol. 21, Dec. 1, 1933, pages 852-853. Discusses the methods of (1) Meller who employs 3 horse-shoe magnets. The flux is measured in the magnet placed between the other two. Inhomogeneities in the weld result in inconsistencies in the flux. (2) Kiesskalt-Schweitzer (Gerlach principle) method. Underlying principle is the measurement of induced current impulses due to the magnetic normal component emerging at inhomogeneous spots of a magnetized body. (3) Ramsauer method utilizing potential differences between 2 probe couples measured with a differential galvanometer. EF (9d)

Magnetic Testing of Welded Joints and Pieces (Magnetische Prüfung von Schweissverbindungen und Werkstücken) J. Pfaffenberger. *AEG Mitteilungen,* July 1933, pages 133-135; *Metal Stampings,* Vol. 6, Oct. 1933, page 246. See "Magnetic Testing of Weld Joints and Work Pieces," *Metals & Alloys,* Vol. 6, Mar. 1934, page MA 96. MS+Ha (9d)

Non-Destructive Testing of Welds According to the File Dust Test (Zerstörungsfreie Prüfung von Schweissnähten nach dem Feilspäneprüfverfahren) Nürnberger. *Die Wärme,* Vol. 56, Oct. 14, 1933, pages 673-676. Paper before the Meeting of the Rheinisch-westfälische Dampfkessel-Überwachungs-Vereine, Essen, 1933, deals with a magnetic testing method invented by Roux. A magnet with 2 pole shoes is slowly moved along underneath the welded seam and the flux is made visible on the opposite side by means of filings strewn on a piece of paper. The welded test piece is struck by a hammer. Not only the inhomogeneities in the weld clearly appear in the file dust picture, but also the nature of the defects can be revealed according to the 8 photographs accompanying the paper. The testing method is best suited and already commercially employed for water gas welded joints. Difficulties in regard to other welding methods are admitted. EF (9d)

The Magnetic Method of Crack Detection. H. D. Manton. *Commonwealth Engineer,* Vol. 21, Dec. 1, 1933, pages 133-135. Complete breakdown of machinery parts could frequently be prevented if incipient cracking, which is a prelude to failure, were detected in time. The early cracking is not visible under ordinary inspection methods. The latest and most effective is the magnetic method in which the body of the metal is magnetized and treated with magnetic material in a way that reveals the presence of the crack through magnetic leakage at its surfaces. The method and its application to steel pinions in the Victorian railways are described. WH (9d)

Demagnetizing Machine Tools. R. M. Churchill. *American Machinist,* Vol. 78, Feb. 14, 1934, pages 150-151. Arrangement for demagnetizing larger parts, as lathes, etc. which have become magnetic and slow up production is described. Ha (9d)

Electromagnetic Testing Method for Wire Ropes. (Elektromagnetisches Verfahren zur Prüfung von Drahtseilen.) A. Otto. *Glückauf,* Vol. 69, May 27, 1933, pages 471-475. A solenoid is arranged over the rope and within it a test coil which under strong magnetization of the rope by the solenoid records very accurately any irregularity in the rope. The particular application of this sensitive method for testing hoist ropes in mining operations is described. Photographs show the changes of deflection when one or more strands are defective. Ha (9d)

METALLOGRAPHY (10)

J. S. MARSH, SECTION EDITOR

A Rapid Method of Determining the Crystal Axes of Single Crystal Wires of Certain Metals. R. Roscoe & P. J. Hutchings. *London, Edinburgh & Dublin Philosophical Magazine & Journal of Science,* Ser. 7, Vol. 16, 1
Sept. 1933, pages 703-707. The elliptical slip bands which appear on the surface of stretched single-crystal wires permit, with certain restrictions, determination of axis orientation before and after stretching. RHP (10)

Absorption Coefficients for X-rays in the Neighborhood of the L-borders of the Elements Au, Pt, and Ag (Die Absorptionskoeffizienten für Röntgenstrahlen in der Umgebung der L-Kanten bei den Elementen Au, Pt und Ag) M. Wolf. *Annalen der Physik,* Series 5, Vol. 16, Apr. 1933, pages 973-984. The X-ray spectrum of the L-range was investigated and the absorption and number of dispersion electrons determined. 17 references. Ha (10)

Crystal Parameters of Four Metals when under Reduced Pressure. E. A. Owen 2
& E. L. Yates. *London, Edinburgh & Dublin Philosophical Magazine & Journal of Science,* Ser. 7, Vol. 16, Sept. 1933, pages 606-610. Previous work was reported in the Philosophical Magazine, Vol. 15 (1933), page 472. Parameters of spectroscopically pure elements Au, Pt, Pd, and Rh were measured with a precision X-ray camera which was mounted in an enclosure which could be evacuated. Specimens were heated in this vacuum to a high temperature and were maintained at this temperature for a definite period of time. When cooled to atmospheric temperatures the specimens were X-ray photographed while still in the vacuum. Maximum possible temperature was 600° C. Tabulated results are in agreement with published data. RHP (10)

The Non-existence of a Higher Nickel Carbide (Die Nichtexistenz eines höheren 3
Nickelcarbides) Jürgen Schmidt. *Zeitschrift für anorganische und allgemeine Chemie,* Vol. 216, Dec. 12, 1933, pages 85-98. Experiments to form a nickel carbide higher than Ni_3C by carburizing Ni with CO had a negative result; some C is absorbed but density and crystal lattice are not changed. Ha (10)

An Outline of Metallography. William Campbell. School of Mines Columbia University, 46 pages. Reproduced from typescript, not dated. Outline for use of students in the course in physical metallurgy. Selected references under each heading make the outline especially useful from the bibliographic point of view. H. W. Gillett (10)-B-

Studies on Ternary System Aluminum-Antimony-Magnesium (Studien am Dreistoffsystem Aluminium-Antimon-Magnesium) W. Guertler & A. Bergmann. 4
Zeitschrift für Metallkunde, Vol. 25, Apr. 1933, pages 81-84; May 1933, pages 111-116. Previous work on the binary systems Al-Mg, Mg-Sb, and Al-Sb is reviewed. New work on the Al-Sb system is reported, including thermal analysis and microscopic studies. This system shows a single maximum on the liquidus at the compound AlSb and at 1050° C. with eutectics on either side, both very near to the pure components. A detailed study of the constitution of Al-Sb-Mg alloys, chiefly by microscopic observations of structure and also by thermal analysis. Approximately forty-five alloys were prepared and studied, chiefly following quasi-binary sections. The structures are illustrated by photomicrographs, and the results are expressed in tables and diagrams. A miscibility gap in the liquid state was found
which extends from 9 to 98% Mg_3Sb_2 in the quasi-binary sections Al-Mg_3Sb; 5
towards the Sb corner to 73% Sb. Accordingly the practical possibilities of alloying Al simultaneously with Sb and Mg are very limited. RFM (10)

Observing Formation of Martensite in Certain Alloy Steels at Low Temperatures. O. A. Knight & Helmut Müller-Stock. *American Institute Mining & Metallurgical Engineers, Technical Publication* No. 537, Feb. 1934, 7 pages. A microscope was equipped for observing temperatures as low as – 150° C. Low-C, high-Ni steels were quenched in brine, polished, cooled to low temperatures, and the polished surface observed at the low temperatures. The steels were austenitic as quenched and transformed to martensite on cooling to low temperatures. The formation of martensite needles was observed, but they formed so
fast that it was impossible to take moving pictures showing the formation of individual needles. In several instances, however, the observer was able to see the 6
actual propagation of a needle. The formation of a needle is said to be like the raising of a ridge by a mole, only very much faster. 15 references. JLG (10)

The Lithium-magnesium Equilibrium Diagram. Otto H. Henry & Hugo V. Cordiano. *Metals Technology, American Institute Mining & Metallurgical Engineers, Technical Publication* No. 536, Feb. 1934, 14 pages. Previous work on the Li-Mg system is reviewed. Mg-rich alloys containing up to 15% Li were melted under a cover of LiCl and KCl, but alloys higher in Li could not be prepared in this manner. The latter materials were melted in a steel bomb into which was inserted a steel pyrometer tube. The liquidus was determined from cooling curves and the solidus from heating curves. Mg-rich alloys were examined
microscopically. Only 2 solid phases are formed. There is a peritectic line at 7
591° C., the phases in equilibrium being Mg-rich (α) solid solution containing 4.9% Li, β solid solution containing 10% Li, and melt with 13% Li. The region of existence of 2 solid solutions, from about 5 to 10% Li, varies little with temperature. 13 references. JLG (10)

The Constitution of Copper-iron-silicon Alloys. D. Hanson & E. G. West. *Journal Institute of Metals,* Vol. 54, 1934, 22 pages (Advance copy). Cu-rich alloys containing up to 8% Si and 8% Fe were studied and the complete diagram for this field worked out. Liquidus and solidus temperatures were determined by thermal curves and by examination of quenched specimens. The α
boundaries in the solid were determined by microscopic examination of samples 8
given different heat treatments. The solubility of Fe in Cu is decreased by the presence of Si. In most of the alloys examined Fe existed as Fe containing small amounts of Si and Cu in solution. In some alloys a compound is formed, probably FeSi. None of the alloys could be hardened appreciably by a precipitation-hardening treatment. 9 references. JLG (10)

New X-Ray Camera for Investigation of Materials at Elevated Temperatures by Means of Hot Gas (Eine neue röntgenographische Einrichtung zur Untersuchung von Werkstoffen bei höheren Temperaturen mittels erhitzten Gasstromes) E. Franke. *Technische Blätter der deutschen Bergwerkszeitung,* Vol. 23, Dec. 31, 1933, page 734. Disadvantages resulting from electric heating of samples to be X-rayed are first briefly considered. A simple device as proposed by
Wassermann for heating samples by a current of hot gas is described. GN (10) 9

The Nature of the Solid Phase in the System Antimony-Bismuth. W. F. Ehret & M. B. Abramson. *Journal American Chemical Society,* Vol. 56, Feb. 1934, pages 385-388. X-ray diffraction and microscopic examinations of annealed specimens of Sb-Bi alloys show them to consist of one phase only, corresponding to a system which forms a complete series of solid solutions. The lattice parameter was found to vary linearly with the mole percent of the components. MEH (10)

Radium Adsorption by Nickel. J. A. Cranston & C. Benson. *Metal Industry,* London, Vol. 42, Apr. 21, 1933, page 428. See "Ratio of Adsorption
of Radium-B and Radium-C on Nickel," *Metals & Alloys,* Vol. 5, Feb. 1934, page MA 44. Ha (10) 10

Etching Metallic Surfaces in an X-ray Tube. Francis H. Clark. *Metals & Alloys,* Vol. 4, Sept. 1933, page 146. The writer shows pictures of etched surfaces obtained on polished metal by the action of electron bombardment as described in Nakaya's paper, *Proceedings Royal Society,* Vol. 124, May-July 1929. WLC (10)

Crystallization Velocity and Nucleus Number of Tin, Bismuth and Lead (Die Kristallisationsgeschwindigkeit und die Kernzahl von Zinn, Wismut und Blei) G. Tammann & H. J. Rocha. *Zeitschrift für anorganische und allgemeine Chemie*, Vol. 216, Dec. 12, 1933, pages 17-25. A method for determining the crystallization velocity by measurement of grain size of a monocrystal is developed and illustrated by application to Sn, Bi and Pb. The linear crystallization velocity depends on the undercooling of the melt and dimensions of the container; it was found for Bi to average 1.55-2.0 cm./min., for Pb 3-5 cm./min., for Sn 31-84 cm./min. The influence of dimension of container and of undercooling is shown by tabulated data. Ha (10)

Lattice Structure of Lithium-Cadmium Alloys (Gitterstruktur der Lithium-Kadmium-Legierungen) E. Zintl & A. Schneider. *Zeitschrift für Elektrochemie*, Vol. 40, Feb. 1934, page 107. Preliminary report. LiCd has a cubic lattice similar to NaTl; Li_3Cd face-centered cubic lattice with 4 atoms in the elementary cell and statistical distribution of atoms. 5 references. Ha (10)

Lattice Distortion in Nitrided Steels and Theory of Hardness. W. A. Wood. *London, Edinburgh & Dublin Philosophical Magazine & Journal of Science*, Ser. 7, Vol. 16, Sept. 1933, pages 719-727. Brief bibliography. Steels were nitrided in a stream of NH_3 for several hours at about 500° C. X-ray analysis was made of Cr-Al type steels before and after nitriding. Specimens were also examined after nitriding at 500° C. for 100 hours. This method produces a surface layer of nitrides and a case characterized by an abnormally diffused and weakened spectrum. Extreme hardness values are associated with this type of spectrum. The interpretation of the X-ray results requires the assumption of a distorted atomic lattice and a disturbance of the electron distribution. A tentative theory of hardness on the basis of the latter assumption is developed. RHP (10)

Lattice-parameter Change of α-Iron under Hydrogen (Ueber die Gitter-parameteränderung des α-Eisens bei der Wasserstoffbeladung) F. Wever & B. Pfarr. *Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung*, Düsseldorf, Vol. 15, No. 11, 1933, pages 147-148. H forms with α-Fe an interstitial solid solution in which the H atoms are arranged in the gaps of the α-Fe lattice. Parameter changes were followed by means of X-ray tests. 7 references. Ha (10)

Electric Conductivity and Diagram of State of Binary Alloys (Elektrische Leitfähigkeit und Zustandsdiagramm bei binären Legierungen) G. Grube & J. Hille. *Zeitschrift für Elektrochemie*, Vol. 40, Feb. 1934, pages 101-106. The diagram of state of the complete system Mg-Tl was investigated. Compounds Tl_2Mg_5, $TlMg_2$ and TlMg were confirmed. 6 references. Ha (10)

Crystal Structure and Ferromagnetism of Manganese-Aluminum-Copper Alloys (Kristallstruktur und Ferromagnetismus der Mangan-Aluminium-Kupferlegierungen) Otto Heusler. *Annalen der Physik*, Series 5, Vol. 19, Jan. 1934, pages 155-207. According to Heisenberg's theory, ferromagnetism is due both to electron configuration of the atoms and to the crystal structure. This was experimentally investigated on Mn-Al-Cu alloys and their magnetization determined as a function of field strength, temperature, composition and aging. The magnetic properties must be ascribed to a compound Cu_2MnAl which, as a whole, is ferromagnetic. Ha (10)

An X-Ray Investigation of the Gold-Rhodium and Silver-Rhodium Alloys. Roy W. Drier & Harold L. Walker. *London, Edinburgh & Dublin Philosophical Magazine & Journal of Science*, Ser. 7, Vol. 16, Aug. 1933, pages 294-298. Au-Rh system is one of two solid solutions. The Au lattice contracted a maximum of 0.011 A. U., which according to Vegard's law, indicates a solubility of 4.1 atomic % of Rh in Au. Limiting spectra and consideration of Westgren's and Almin's findings indicated that a better value for this solubility would be nearer to 8 than to 4 atomic %. The edge of the unit cell of Rh expanded as much as 0.003 A. U. Solubility of Au in Rh is between 1.1 and 2.5 atomic %, with the possibility of its being nearer 1.5 atomic %. Solubility of Ag in Rh or Rh in Ag could not be detected. It is probable that they are at least minutely soluble in each other. RHP (10)

Investigation of the Orientations in Thin Evaporated Metallic Films by the Method of Electron Diffraction. K. R. Dixit. *London, Edinburgh & Dublin Philosophical Magazine & Journal of Science*, Ser. 7, Vol. 16, Dec. 1933, pages 1049-1064. An investigation of the effect of temperature on the orientations of the small crystals in thin metallic films. The films, 10^{-4} to 10^{-6} cm. thick, of Ag on Mo, quartz, and glass, of Al on Mo, and Zn on Mo have been studied over the whole range of temperatures above the room temperature. Different orientations have been observed which do not depend on the nature of the base. A theory is proposed that these thin deposits behave as a two-dimensional gas. RHP (10)

The Ternary Phosphide Eutectic in Cast Iron in the Light of a Recent Etching Method (Das ternäre Phosphideutektikum im Gusseisen nach neuer Aetzung) W. Heike & J. Gerlach. *Die Giesserei*, Vol. 20, Dec. 22, 1933, pages 561-563. A method of etching cast iron samples is described by which the ternary phosphide eutectic is made visible in many types of cast iron even if only minute amounts of P are present. It appears as a dark constituent in a light ground mass. The solutions required are: (1) 2% alcoholic HNO_3 solution; (2) 100cc. distilled H_2O, 100cc. alcohol, 10g. tartaric acid, 10g. alum, 10g. ferric chloride and 2g. ferric sulphate; (3) 10% KOH solution; (4) 10% KOH solution saturated cold with potassium permanganate. Exact procedure is given and several examples of application are described. 8 references. Ha (10)

The Effect of Heat Treatment on the Production of Frictional Electric Charges on Metals. P. A. Mainstone. *London, Edinburgh & Dublin Philosophical Magazine & Journal of Science*, Ser. 7, Vol. 16, Dec. 1933, pages 1083-1096. 8 references. Prolonged heating of Al and Ni at very low pressures lowers the normal negative frictional charge, with a partial slow recovery after the metal surface has been re-cooled. Heating in N at atmospheric pressure gives a similar effect. Widely varying results may be obtained after degassing the metal and reheating it at about 300° C. in H or N. Re-polishing or etching, however, very largely restores the surface to its original state. When polished Pt is de-gassed and heated in H at about 250° C. the frictional charge changes from negative to positive. RHP (10)

Dilatometric Study of Stainless Steels and Their Behavior After Heat Treatment at Low Temperatures. V. Kuznetzoff & I. Liferenko. Thesis, Carnegie Institute of Technology, 1933. 36 typed pages, 3 tables, 49 figures, 10 references. Unpublished, available at Carnegie Institute of Technology Library. Three steels, of the plain Cr type, carrying 0.2 to 0.5% adventitious Ni, were studied. They contained 0.07% C, 17.6% Cr, 0.5% Ni and 0.12% C, 12.7% Cr, 0.2% Ni; 0.18% C, 17.7% Cr, 0.3% Ni. Inversions were shown to be sluggish. The 0.12% C, 12.7% Cr steel transformed on cooling, at a very slow rate, at around 770-760° C. The 0.07% C, 17.6% Cr steel showed a split transformation on cooling, the Ar″ being around 260° C. The 0.18% C, 17.7% Cr steel showed no definite critical points. The 0.12% C, 12.7% Cr steel, heated to 900°C, transferred to another furnace running at 350°C, held 4 hours and then air cooled, showed a tensile strength of 190,000 lbs./in.², 122,000 lbs./in.² yield strength, 9% elongation, and 25% reduction of area. No liquid quenching was done to obtain these properties. Holding 8 hrs. at 350°C. slightly raised the tensile strength, dropped the yield strength to 97,500 lbs./in.², and very slightly raised the ductility. Similar low-temperature holding at 260°C. after heating at 850°C. was tried on the 0.07% C, 17.6% Cr steel, but was not very effective, since it altered the properties only moderately from those obtained on a furnace cool. The 0.18% C, 17.7% Cr steel, after heating to 950°C. and transferring to a furnace at 350°C. was not improved over an air cool. Agglomeration of carbides was studied; it seldom takes place under the treatments used. HWG (10)

Possibilities of Application of X-Rays for the Detection of Stresses in Materials and Structural Parts (Anwendungsmöglichkeiten der Roentgenstrahlen zur Ermittlung von Spannungen in Werkstoffen und Bauteilen) R. Berthold. *Zeitschrift für Technische Physik*, Vol. 15, Jan. 1934, pages 42-48. A new method which permits investigation of the fine structure of a metal was developed; it utilizes the X-ray back-reflection principle. This method is independent of the size of the sample. The width of the interference circles on the film indicates whether stresses are present in the sample and it is shown how they can be calculated; the accuracy of the method is at present ± 5 kg./mm.². Suggestions are made for employing this method for controlling certain heat-treatment processes and also cold-deforming processes. 6 references. Ha (10)

Transformation Kinetics of Austenite. IV. Magnetic Investigations of Carbon Steels (Zur Umwandlungskinetik des Austenits. IV. Magnetische Untersuchungen an Kohlenstoffstählen) Heinrich Lange. *Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung*, Düsseldorf, Vol. 15, No. 20, 1933, pages 263-269. An arrangement is described by which the austenite transformation of C steels below 500° C. can be magnetically observed under high magnetic fields. Results indicate that at temperatures below 400° C. iron-carbide is formed in a series of different forms of varying C content. 5 references. Ha (10)

Intensity Distribution in the Spectrum of Beryllium Oxide. R. C. Johnson & E. Gordon Dunstan. *London, Edinburgh & Dublin Philosophical Magazine & Journal of Science*, Ser. 7, Vol. 16, Supp. No. Aug. 1933, pages 472-478. Results of theoretical and mathematical studies, including several graphs. RHP (10)

Resistance Measurements for the Transformation Kinetics of Austenite (Widerstands messungen zur Umwandlungskinetik des Austenits) F. Wever & W. Jellinghaus. *Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung*, Düsseldorf, Vol. 15, No. 13, 1933, pages 167-177. The isothermic transformation of austenite was studied by means of resistance measurements between 375° and 140° C. on wire samples of a steel with 0.89% C and 0.60% Mn. The isotherms between 375° and 280° C. show a slow start of the transformation. Between 280° and 240°, a transformation state exists, and below this temperature to the martensite point the time law is logarithmic. The dependence of the transformation velocity of austenite can be represented, in the whole temperature range, by an expression formally identical with the van't Hoff Law for gas reactions and dilute solutions. Simultaneous measurements of magnetization and resistance show great differences in the temporal course of transformation; the change of resistance goes on faster and stops sooner than the change of magnetization. This is explained by rearrangements taking place in the austenite lattice structure which precede the $\gamma - \alpha$ transformation. These conditions are discussed in detail. 25 references. Ha (10)

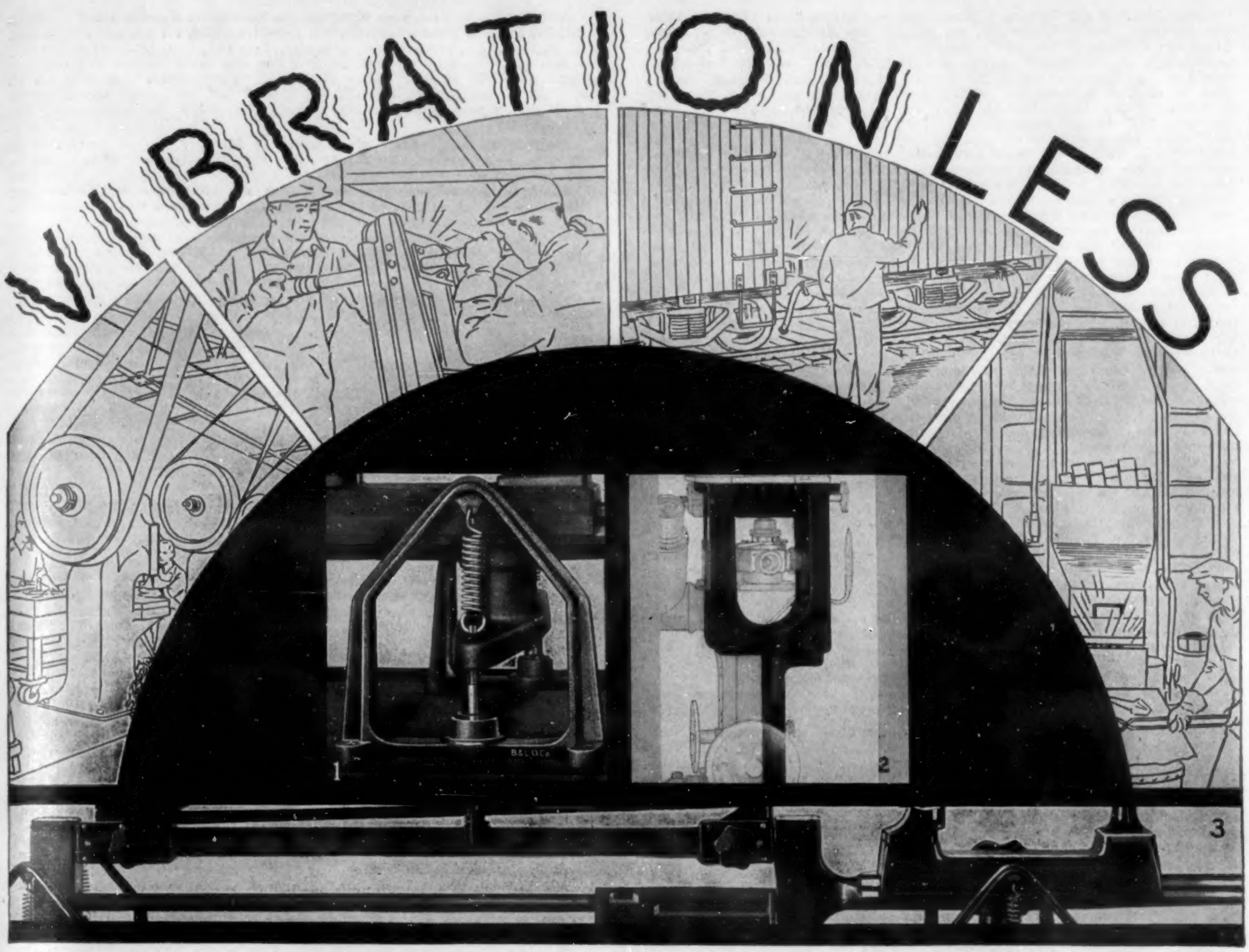
Formation of Lattice Disturbances during Cold-deformation and Their Release during Recovery of the Crystals and Recrystallization (Ueber die Ausbildung von Gitterstörungen bei der Kaltverformung und ihre Rückbildung bei der Kristallerholung und Rekristallisation) F. Wever & B. Pfarr. *Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung*, Düsseldorf, Vol. 15, No. 11, 1933, pages 137-145. The changes of width of interference lines in X-ray spectrograms, the recovery of the crystals, and the course of recrystallization during and after cold working of materials was studied by means of the X-ray reflection method. The width of the spectral lines is increased by cold working, and also by annealing up to 400° C.; it decreases above this temperature very rapidly due to recrystallization. It is shown how this behavior can be utilized for study of a cold working process. Recrystallization counteracts the strengthening of the material the more effectively the greater the deformation. This was found at 700° C. The width of the lines decreases with increasing deformation. The method is illustrated by several examples. 37 references. Ha (10)

The Effect of Cutting Single-crystal Plates of Aluminium with Knife Edge. Sadajiro Isotani. *Memoirs College of Science, Kyoto Imperial University*, Vol. 16, Sept. 30, 1933, pages 353-356. (In English.) When a single plate of aluminum was cut with a knife edge, the single crystal was broken up into microcrystals, and they were so arranged in an imperfectly fibrous manner that the axis of the fiber was parallel both to the cut made by the knife edge and to the plane of the test-piece, regardless of initial orientation. As for the relationship among the maximum angle of rotation of the microcrystals around the fiber axis, the thickness of the test piece and the angle of the knife edge, it was found that the maximum angle of rotation decreased almost linearly as the test piece became thicker regardless of the velocity of the cutting, and also slightly decreased when the angle of the knife edge increased. The range of influence of the cutting upon the test piece increased almost linearly with increase of thickness of the test piece, and decreased slightly with increase of the angle of the knife edge. HN (10)

A Critical Study of the Hardness Behaviour of Duralumin. Hugh O'Neill, J. F. B. Jackson & G. S. Farnham. *London, Edinburgh & Dublin Philosophical Magazine & Journal of Science*, Ser. 7, Vol. 16, Nov. 1933, pages 913-929. 6 references. Commercial duralumin containing 4.15% Cu, 0.19% Si, 0.49% Mg, 0.42% Fe, 0.64% Mn, and the remainder Al was investigated by means of Meyer analysis. A table gives the results of various heat treatments. Samples were quenched at temperatures from 490° to 515° C. and aged for periods varying from 4 to 6 days. Specimens of fully aged alloys were reheated at temperatures varying from 100° to 360° C. and for periods varying from 20 min. to 257 hours. Gives hardness for each of these treatments. Considers structure and hardness of quenched duralumin reheated before aging, then aged and rolled. Table and graph show results of treatments at various temperatures and for various periods. Specimens were examined with the X-ray spectrograph and a lattice size, and group type for each is given. Ball-hardness tests on the basis of Meyer analysis indicate that the normal age hardening of quenched duralumin, and accelerated aging at temperatures below 150° to 200° C. are not precipitation phenomena. The age-hardening process has effects somewhat similar to those obtained when a metal is slightly cold-worked. Precipitation can be induced in either freshly quenched or fully aged duralumin by severe heat treatment. It has not been found, in general, to give hardness results superior to those obtained from the normal aging treatment at room temperature. RHP (10)

The Thermal Expansion of Zinc by the X-Ray Method. E. A. Owen & John Iball. *London, Edinburgh & Dublin Philosophical Magazine & Journal of Science*, Ser. 7, Vol. 16, Supp. No., Aug. 1933, pages 479-488. When a cast specimen of Zn is rolled, the crystals tend to definite orientation in the material. X-ray photographs through thin sheets show that the hexagonal units gradually turn until, after severe rolling, the basal planes become parallel to the surface of rolling. X-ray spectrum photographs were taken with a Muller camera as the specimen was maintained at various temperatures ranging from room temperature to 400° C. Fine filings of Zn were annealed in vacuo at 300° C. for about one hour. Filings were mounted in a layer 0.07 mm. thick on a 0.60 mm. glass fiber. Mean values of the parameters of Zn are axial ratio 1.856, base side 2.6590 A. U. Even at 400° C. the crystal structure remains a close-packed hexagonal. This indicates that no allotropic modification of Zn exists up to this temperature. From the values of the parameter and axial ratio, the mean thermal coefficient of linear expansion along, and at right angles to, the hexagonal axis, and the mean volume coefficient, are calculated for different ranges of temperature. Results are shown in extended tables. RHP (10)

Some Wave-length Determinations in the very Soft X-Ray Region. F. C. Chalklin & L. P. Chalklin. *London, Edinburgh & Dublin Philosophical Magazine & Journal of Science*, Ser. 7, Vol. 16, Supp. No., Aug. 1933, pages 363-389. Data on Mo, Rh, Pd, Ag, W, Ta and Pt are tabulated. RHP (10)



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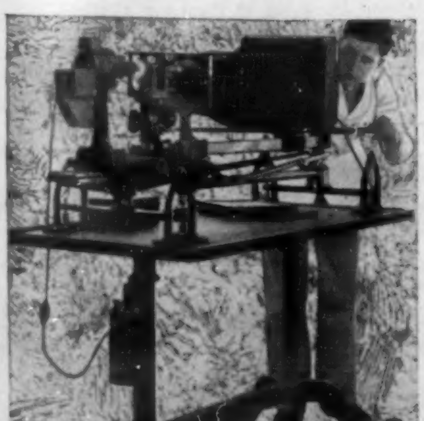

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OPTICAL INSTRUMENTS FOR THE INDUSTRIES

Crystal Structure and Forming as Exemplified in Elektron Metal (Kristallstruktur und praktische Werkstoffgestaltung am Beispiel des Elektronmetalls) WALTER SCHMIDT. *Zeitschrift für Metallkunde,* Vol. 25, Oct. 1933, pages 229-236. A discussion of the forming of the alloy Elektron based upon previous observations on the crystallography of the deformation process and upon new observations, in which it is shown that crystallographic reasoning, at least in this case, is of practical importance. Elektron metal may be compressed easily without fracture above 225° but not below, because at the higher temperatures slip occurs on many atomic planes while at the lower on only one, the basal plane. Crystal recovery is very rapid at the higher temperatures, as shown by the lower maximum load and greater elongation in tensile curves taken at slow speeds; the work area under the curves is constant, however. Accordingly slow velocities of deformation (rolling, extrusion, forging, etc.) are used to avoid high forming loads and brittleness. Twinning is upon a pyramidal face; it obtains when pressure forces are applied parallel to the basal plane or tensile forces parallel to the hexagonal axis. Twinning and slip thus both occur dependent upon the direction of force and their relative roles will vary. Fine grains inhibit twinning. The difference between the yield point in tension and compression found in samples bearing the characteristic preferred orientation (the basal plane lying in the plane of rolling) is caused by twinning and may be reduced by developing fine grains which reduce the twinning tendency; this is done commercially by overheating the metal just before casting. The growth of large grains either during hot-rolling or hot-extrusion may be restricted by the use of short times followed by rapid cooling, during cold-rolling and subsequent annealing by slow speeds of rolling in which internal strains do not build up so rapidly. Forging large pieces is difficult owing to tendency to recrystallize and subsequently to twin, and to form preferred orientations and resulting directional properties; a treatment consisting of forging and annealing at progressively lower temperatures was found to diminish though not to eliminate this anisotropy. Pronounced direction properties may occasionally be useful technically when high yield point is required in known directions. Directional properties may also be reduced by combination of forging and extension in two directions standing at right angles. The preferred orientations produced on forging (basal plane perpendicular to piece surface) is the most favorable for rolling and this fact is employed practically. Grain growth is dependent upon type of preferred orientation obtaining and the direction of application of the deforming force. The preferred orientation developed on rolling is such as to reduce the elongation in a direction lying in the sheet surface in the cold and such forming operations should be performed hot. A final cold pass of 10% causes twinning sufficient to improve the elongation and this is present practice; using this method the per cent elongation has been increased to an average value of 16 from the old value of 10. Such sheets still possess preferred orientation; this may be partly broken up by passing the sheet through intermeshing rolls which bend the sheet back and forth and thus, by reason of the tensile stresses in the fibers lying in the surface of the sheet, cause twinning with resultant improved elongation (an improvement twofold in the cross direction and fivefold in the rolling direction); the twinning process thus initiated creates new orientations which create new possibilities for slip. RFM (10)

Lattice Constant and Grain Size in Gold-Silver Alloys (Gitterkonstante und Korngrösse bei Gold-Silberlegierungen) P. WIEST. *Zeitschrift für Physik,* Vol. 81, No. 1/2, 1933, pages 121-128. The lattice constants of cast monocrystals and recrystallized polycrystals were determined by precision methods. Heat treatment and grain size change the constant materially. 11 references. Ha (10)

Crystal Structure and Composition of Cubic Chromium Carbide (Den kubiska Kromkarbidens kristallbyggnad och sammansättning) ARNE WESTGREN. *Jernkontorets Annaler,* Vol. 117, Oct. 1933, pages 501-512. 11 references. The carbide phase of stainless steel with 13% Cr and 0.1-0.4% C has the same structure as the lowest Cr carbides. This is face-centered cubic with a lattice parameter of 10.638 A.U. and the nearest stoichiometric composition is Cr_4C. A reexamination of the grouping shows that it is in fact $Cr_{23}C_6$. The space grouping is O_h^5 and the atomic positions in Wyckoff's notation are

4 Cr at 4 (a); 32 Cr at 32 f
8 Cr at 8 (c); 48 Cr at 48 h
24 Cr at 24 (e)

with u = 0.385, v = 0.165, and w = 0.275. In a Cr-W carbide, the W atoms are mainly at 8 (c) and therefore have the formula $Cr_{21}W_2C_6$. In low-W and Mo steels, the carbides are analogous to cubic Cr carbide. These substances may be considered to be $Fe_{21}W_2C_6$ and $Fe_{21}Mo_2C_6$ in which W and Mo are largely replaced by Fe. HCD (10)

Influence of Alloying Elements on Allotropy of Iron. V. N. SVECHNIKOV. *Domez,* No. 8, 1932, pages 6-15. In Russian. See *Metals & Alloys,* Vol. 4, Dec. 1933, page MA 382. (10)

Diffusions That Take Place in Iron-silicon Alloys During Heat Treatment. N. A. ZIEGLER. *Metals Technology, American Institute Mining & Metallurgical Engineers, Technical Publication* No. 538, Feb. 1934, 6 pages. Samples of electric sheet containing 4% Si were heated in oxidizing atmospheres, in vacuum, and in H for protracted periods. Surface layers were removed and analyzed. Results indicated that annealing in H or in oxidizing atmospheres lowered the C content of the surface layers but did not change the Si content. It was noted that a pinkish-white layer formed between the outer scale crust and the sound metal. Analysis of this scale showed that it closely corresponded to $FeSiO_3$. It is postulated that this film acts as a barrier to the flow of O into the melt but does not prevent the diffusion of C to the surface. JLG (10)

Notch-Toughness and Width of X-Ray Diffraction Lines in Steel (Kerbzähigkeit und Linienbreite bei Röntgen-Interferenzaufnahmen von Stahl) E. SIEBEL, R. BERTHOLD & P. KÖTZSCHKE. *Archiv für das Eisenhüttenwesen,* Vol. 7, Dec. 1933, pages 355-358. The X-ray diffraction lines of a Cr-Ni steel subject to temper brittleness seemed to be wider and less distinct in the tough condition, i. e., after tempering at 500°C followed by oil quenching, and narrower and sharper in the brittle condition, i.e., after similar tempering followed by furnace cooling. SE (10)

Standard Rules Governing the Preparation of Micrographs of Metals and Alloys, Including Recommended Practice for Photography as Applied to Metallography. *American Society for Testing Materials* A. S. T. M. Designation: E2-30; *American Standards Association* A. S. A. No. Z30.1-1933, 9 pages. AHE (10)

Solubility of Oxygen in Solid Copper. F. N. RHINES & C. H. MATHEWSON. *American Institute Mining & Metallurgical Engineers, Technical Publication* No. 534, Feb. 1934, 17 pages. Previous work on the Cu-O system is reviewed. Some very pure electrolytic Cu was obtained, redeposited in a nitrate bath and melted in vacuum. The solid solubility of O in Cu was determined by heating the pure Cu in air for prolonged periods at different temperatures, quenching, removing the scale, and determining O content by loss in weight when heated in H. The results indicated that the solid solubility was 0.007% at 600°C. and 0.015% at 1050°C. The solid-solubility curve of O in Cu suggested that precipitation hardening might be possible but mechanical tests showed that no increase in hardness resulted when O was precipitated from a supersaturated solution. A special etch was developed which showed that Cu_2O particles were precipitated when a quenched alloy was reheated. It was found that O can be extracted from Cu by heating in the absence of O. Cu_2O was heated at 1000°C. under a vacuum of 2.5 to 4 microns; some oxide was lost by evaporation and some by decomposition. On the basis of results obtained on heating Cu-O alloys under low pressures and results obtained by other investigators a pressure-temperature diagram for the system was outlined. Using this provisional diagram, temperature-concentration diagrams for several pressures were constructed. 15 references. JLG (10)

Activity of C in Fe-C-alloy Melts and the Equilibrium between C and O (Kolets aktivitet i smälta järn-kol-legeringar och jämvikten mellan kol och syre i smält stal) G. PHRAGMEN. *Jernkontorets Annaler,* Vol. 117, Dec. 1933, pages 563-571. 7 references. From an examination of the equilibrium diagram it is concluded that the activity of C in molten Fe-C alloys in equilibrium with oxide and CO at 1550°C. lies between 0.00025 and 0.0005 and the percent carbon between .0004 and 0.0008. The solubility product of C and O lies between 10^{-7} and 2×10^{-7}. HCD (10)

Contribution to the Study of Inclusions in Steels. A. M. PORTEVIN & R. PERRIN. *Engineering,* Vol. 135, May 12, 1933, pages 528-530. See *Metals & Alloys,* Vol. 5, Jan. 1934, page MA 7. LFM (10)

Alloys of Gallium with Aluminum (Ueber die Legierungen des Galliums mit Aluminium) N. A. PUSCHIN & V. STAJIC. *Zeitschrift für anorganische und allgemeine Chemie,* Vol. 216, Dec. 12, 1933, pages 26-28. The Ga-Al diagram was determined by thermal analysis; 3 compounds exist: $AlGa_2$, melting point 281°, AlGa, melting point 374°, and Al_2Ga, melting point 467°; the last exists in 2 modifications, α below 447°, and β between 447° and 467°. Ha (10)

An Investigation on the Ternary Alloys of Al-Ag-Mg. BUNTARO OTANI. *Kinzoku no Kenkyu,* June 1933, Vol. 10, pages 262-276. (In Japanese) The equilibrium diagram of the alloys of aluminium and a binary intermetallic compound AgMg was investigated by means of the thermal analysis, electric-resistance measurement, and microscopic examination. A ternary intermetallic compound AlAgMg, which is formed at 570° by a peritectic reaction melt + AgMg $\rightleftarrows$ AlAgMg, was found. The solubility of this compound in aluminium is 14% at 538°, 5.4% at 520°, 4.4% at 500°, 2.4% at 400°, and 0.4% at 300° C. The combined effects of AgMg and Cu, Si, Mn and Ni upon Al was also investigated. It was found that the alloy containing 6% of AgMg and 4% Cu shows excellent mechanical properties after suitable heat-treatment. When the alloy was quenched from 480° C, and heated at 160° for 55 hours, the Brinell hardness was 148 and the tensile strength 47.4 kg./mm.^{2}. KT (10)

Gold-Manganese System (Ueber das System Mangan-Gold) H. MOSER, E. RAUB & E. VINCKE. *Mitteilungen des Forschungsinstituts und Probieramts für Edelmetalle,* Vol. 6, Mar. 1933, pages 129-136. See *Metals & Alloys,* Vol. 5, Jan. 1934, page MA 7. Ha (10)

Studies upon the Widmanstätten Structure, VI—Iron-rich Alloys of Iron and Nitrogen and of Iron and Phosphorus. ROBERT F. MEHL, CHARLES S. BARRETT & H. S. JERABEK. *American Institute Mining & Metallurgical Engineers, Technical Publication* No. 539, Feb. 1934, 18 pages. Ingot Fe purified in H at high temperatures was nitrided at 500° C. with a stream of NH_3 and H_2 containing not over 50% NH_3. The nitride formed was proved by X-ray diffraction to be Fe_4N. The Fe_4N was precipitated as plates on cooling. Analysis of the structure by the usual methods showed that Fe_4N plates formed on [210] planes of α Fe and that the [211] planes in Fe_4N were parallel to these planes. Equivalence of interatomic distances suggested that the [001] direction in α Fe was parallel to the $[\bar{1}20]$ direction in Fe_4N. Comparison of atom positions in several adjacent atom layers shows that the orientation chosen involves minimum movement during precipitation in several atomic layers. In Fe-P alloys the precipitate of Fe_3P takes the form of fragmentary plates lying approximately parallel to [12 1 4] planes. The relationship between the lattice of Fe_3P and α Fe could not be determined. 11 references. JLG (10)

Iron End of the Iron-Manganese-Aluminum System (Die Eisenecke des Systems Eisen-Mangan-Aluminium) W. KÖSTER & W. TONN. *Archiv für das Eisenhüttenwesen,* Vol. 7, Dec. 1933, pages 365-366. The Fe-Mn-Al alloys up to 30% Al and 50% Mn were studied. Only α and γ solid solutions appear as solid phases. SE (10)

An Approach to an Explanation of the Surface Work Functions of Pure Metals. JOSEPH F. CHITTUM. *Journal of Physical Chemistry,* Vol. 38, Jan. 1934, pages 79-84. A study of 4 principles used by the author as guides for his approach to an explanation of the net work function leads to this hypothesis: The slope of the force-distance parabola is identified with the lattice energy of the metal crystal and can be assumed to be equal to a constant times the electrostatic potential energy of the crystal. The author calculates the values of the intrinsic potentials of 19 different metals according to a newly derived formula. The useful Schottky principle is maintained intact. EF (10)

Can Cracking by Predicted? (Peut-on prevoir les tapures?) JEAN CHANZY. *Revue de Métallurgie,* Vol. 30, Dec. 1933, pages 543-551. Analysis alone does not guarantee freedom from cracking. Cracking resulting in seams leaves invisible planes of weakness which develop into seams on subsequent hot working and heat treatment. Ingots of 15% W, 4.5% Cr steel were unevenly and too rapidly cooled after forging. After rolling the billets were thoroughly chipped free of seams using a microscope to ascertain their absence. The position of the seams was carefully punchmarked. Out of 100 billets manufactured into tools 86 showed seams in exactly the same place as the original, though no traces of them was visible before forging and heat-treating operations. Every month for one year all billets received from the steel plant were carefully examined for seams, cleaned, and manufactured into the same tools. The number of seamy tools was compared month by month with the number of seamy billets found in the monthly shipments used for their manufacture. In every case larger number of seamy billets corresponded to higher number of seamy tools. Analysis and thorough chipping cannot prevent seaming on hot working when cooling practice in the steel making plant was unsatisfactory. Rockwelling a sufficient number of samples from the same heat showed that the hardness distribution curve was not symmetrical. Plotting percentage of seamy bars in lots of the same hardness and their hardness against the tendency for cracking in hot working showed that the latter decreases both with the decrease of seamy bars and increasing hardness. For lots of same composition and similarly treated deviations from maximum hardness serves as a measurable criterion of the tendency to crack. For high speed steels this deviation should not be greater than 3 kg./mm.^{2} if the percentage of cracking on usual quenching is to be kept under 10%. When it is greater, divided quenching is absolutely necessary. JDG (10)

Structural Changes in Hypo-Eutectoid Steels on Heating. H. C. H. CARPENTER & J. M. ROBERTSON. *Iron & Coal Trades Review,* Vol. 126, June 9, 1933, page 907. See *Metals & Alloys,* Vol. 5, Jan. 1934, page MA 7. Ha (10)

Constitutional Diagram Gold-Manganese (Das Zustandsdiagramm Gold-Mangan) H. BUMM & U. DEHLINGER. *Metallwirtschaft,* Vol. 13, Jan. 12, 1934, pages 23-25. The Au-Mn diagram was determined by X-ray investigation. For the high temperature area, powder samples quenched from 1000°C. were used. From pure Au to 83.5% by weight Mn a solid solution with face-centered cubic lattice exists, with the lattice constant steadily decreasing in a curved line. Then a small two phase area appears, whose limits could not be accurately determined, probably on account of the very fine-grained structure. At 87% Mn the tetragonal lattice alone was found with a ratio c:a = .996 and a = 3.79A.U. Both the ratio and content decrease with increasing Mn constant and approach the values for γ Mn. The δ phase at 25 atomic % Mn, found by other investigators, was confirmed in single crystals annealed at 200° and had a face centered tetragonal lattice with a = 4.100 and c = 3.986 A. U. This structure is very sensitive to deformation and easily reverts to the cubic. A new, ϵ, phase was found at 50 atomic % Mn at below 700° with a tetragonal body-centered lattice, a = 3.28 and c = 3.14A.U. It also easily reverts to the cubic lattice on deformation. When heated above 700° and quenched the cubic lattice reappears. 7 references. CEM (10)

PROPERTIES OF METALS & ALLOYS (11)

Non-Ferrous (11a)

A. J. PHILLIPS, SECTION EDITOR

Duralumin. FREEMAN HORN. *Mechanical World & Engineering Record,* Vol. 43, Feb. 3, 1933, page 99. Duralumin owes its high tensile strength and ductility to a form of heat treatment known as age-hardening. Discusses solution of Cu in Al and formation of sub-microscopic particles of Cu Al_2, which are distributed through mass of metal, and are believed to have a cementing or keying effect on crystal lattice, preventing inter-slip under effect of stress. The finer and more evenly distributed these particles, the greater the resistance to corrosion. The lower the temperature to which the alloy is quenched, and the more sudden the quenching, the more complete is the retention of solubility and the fineness of the distribution of the precipitated particles. Duralumin contains Cu, Mg, Mn, Si, and Fe which play an important part in the heat treatment process. The metal owes its hardness and strength, in excess of the Al-Cu alloy, to the precipitation of a number of possible complex inter-metallic compounds, the most important of which appears to be the hard Mg_2 Si. Two types of corrosion are found: surface pitting and inter-crystalline. The first reduces the strength in proportion to the cross-section, the second, in addition, reduces the breaking strength. The results of experiments at different quenching temperatures indicate that 500° C. is the minimum temperature to obtain optimum physical properties. There was an increase in inter-crystalline corrosion resistance when quenched in cold or ice water. Explanation: the more drastic quenching prevents the migration of the precipitated particles to the crystal boundaries. Kz (11a)

Non-ferrous Metals, Materials Handbook (Werkstoff-Handbuch, Nichteisenmetalle) Deutscher Gesellschaft für Metallkunde, Verein deutscher Ingenieure, May 1933 additions and Dec. 1933 additions. Beuth Verlag, Berlin. Additions to this loose-leaf handbook are on testing machines, mechanical properties of brasses and of aluminum bronze and corrosion resistance of brasses, bronze and red brass. The treatment is concise, the information being largely given by diagrams.

Current additions to this loose-leaf handbook are: Means of measurement in mechanical testing, aluminum in the food industries, welding of Al and Al alloys, the precipitation-hardening phenomenon, corrected pages on melting furnaces for non-ferrous alloys, additional pages on repeated stress and volumetric analyses and a sheet of micros of Cu-Sn alloys. An index is also provided, since this installment concludes the additions. The current additions are very brief and not particularly important. The whole handbook, however, is useful to the non-ferrous metallurgist. H. W. Gillett (11a)-B-

Essential Properties of Bearing Metals. C. H. BIERBAUM. *Mechanical World & Engineering Record,* Vol. 91, June 24, 1932, pages 606-607. See "Bearing Metals," *Metals & Alloys,* Vol. 3, July 1932, page MA 214. Kz (11a)

Bearing Metals High in Magnesium (Magnesiumreiche Lagermetalle) *Die Metallbörse,* Vol. 22, July 9, 1932, page 867. See "Antifriction Alloys with Magnesium Base," *Metals & Alloys,* Vol. 3, Aug. 1932, page MA 235. EF(11a)

The Phosphor Bronzes (Les Bronzes au Phosphore) LEON GUILLET. *Cuivre et Laiton,* Vol. 5, Nov. 30, 1932, pages 529-530. P is a very good deoxidizer for Cu-alloys and hardener for bronzes. An addition of 0.1% P usually is sufficient for deoxidation; greater amounts up to about 0.4% are used for hardening. In this latter case P acts by its combination with Cu to Cu_3 P forming a eutectic with the binary alloy Cu-Sn. Cast alloys showed following properties:

Composition				Tensile	Elong.	
Cu	Sn	P	Zn	Strength	%	Hardness
90.9	9.0	0	0	24.6 kg./mm.²	23	63
90.8	8.9	trace	0.2	26.5	30	71
89.2	9.6	0.47	0.8	21.4	6	80
89.0	9.7	0.91	0.4	18.7	4	85
88.8	9.2	0.92	1.0	17.3	5.5	83
88.8	9.3	1.17	0.7	18.7	2.5	84

The best hard friction bronzes are composed of 82 to 88% Cu with 0.08 to 0.20% P. The less Cu and the more P present the harder is the alloy. Presence of Zn has same effect as more Cu. Ha (11a)

Copper Nickel Alloys with Tin and Silicon and their Use for Steam Valves (Cupro-Nickels a l'Etain et au Silicium et leur emploie pour Obturateurs de Vapeur) L. GUILLET, A. LE THOMAS & M. BALLAY. *L'Usine,* Vol. 41, Aug. 5, 1932, page 25. See "The Properties of Tin and Silicon in Copper-Nickel Alloys for Steam Valves," *Metals & Alloys,* Vol. 3, Aug. 1933, page MA 242. Ha (11a)

Existence of Resistance Limits for Solid Solutions with Arbitrary Atomic Distribution (Ueber die Existenz von Resistenzgrenzen bei Mischkristallen mit ungeordneter Atomverteilung) R. GLOCKER. *Annalen der Physik,* Series 5, Vol. 14, 1932, pages 40-50. It is known that solid solutions with irregular distribution of such metals as Au and Cu show a peculiar effect with acids which attack only one of the constituents. Probability considerations indicate that such a mixture would be unattacked by acid until the more reactive metal reaches a concentration of 50%. Ha (11a)

Light Metals (Les métaux légers) E. GIRARD. *La Revue de Chimie Industrielle,* Vol. 40, Nov. 1931, pages 325-329; Vol. 41, Jan. 1932, pages 9-12; Feb. 1932, pages 41-45; May 1932, pages 134-138. Physical properties of Al, its electro-plating possibilities and the utilization of Al as plating material, the properties and commercial uses of Mg, Be, Li and Ca are fully dealt with. Then the principal alloys of these light metals are exhaustively discussed including Al-light alloys, Al bronzes, plain and complex Al-Cu alloys, Al-Si alloys with and without additions of Cu, Ni, Mg, Zr, Be, Ti, Fe, Mn, and Al-Ni, Al-Mn, Al-Mg, and Al-alloys containing W, Cr, V. Next are considered the most important Mg-alloys of at least 90% Mg, the balance being Al, Cu, Zn, Mn and occasionally Cd, Si, Ca, Ti, Ce. A special chapter is devoted to the casting of Al and Mg alloys respectively and the article concludes with Mg alloys suitable for forging, pressing and stamping purposes. WH (11a)

Electromotive Forces of Ternary Au-Sn-Hg Alloys (Die galvanischen Spannungen der ternären Gold-Zinn-Quecksilberlegierungen) F. GRIENGL & R. BAUM. *Sitzungsberichte der Akademie der Wissenschaften in Wien, Mathematisch-Naturwissenschaftliche Klasse,* Abt. II b, Vol. 141, No. 8, July 7, 1932, pages 708-722. The iso-potential lines of the Au-Sn-Hg system were experimentally determined. The break of the potential curve corresponding to the intermetallic compounds $AuSn_2$ and AuSn in the binary system does not show up in the ternary. Only in the range of alloys low in Hg the analogous potential changes are noted in both systems. The fact that Au-Sn alloys which already practically display the Au potential exhibit baser and baser values with increasing Hg contents indicates that the compound AuSn is not dissolved as such in the Hg-phase, but in a partly dissociated state, whereby the Sn content is always lower as would correspond to saturated Sn amalgams. The same holds true for the intermetallic compound $AuSn_2$. The dissociation of these compounds in solutions of Hg finds its analogy in the potential measurements of Tammann & Jander (*Zeitschrift für anorganische Chemie,* Vol. 124, 1922, page 105) on diluted amalgams which yielded that the dissociation of the compounds of Au with Cd or Pb, of Ag with Zn or Cd and of Cu with Zn or Cd is practically complete whereas the compounds AuZn, Mg_2Sn, $CuSn_2$ and $CuBi_2$ are only slightly dissociated. Consequently intermetallic compounds may yield various affinity constants. WH (11a)

Refining Alloys of Lead and Antimony (Affinazione delle leghe di piombo e antimonio) V. MONTORO. *La Metallurgia Italiana,* Vol. 25, Oct. 1933, pages 741-747. Micrographic, X-ray, and hardness tests have been utilized in determining the influence of small amounts of sodium on lead-antimony alloys, high in lead. The hardness is increased markedly. Microstructure is not only finer, but
1 also shows new constituents. The X-ray gives a spectrum of the predominating phase, lead, practically unaltered. The space lattice structure is the same as that of the lead, at the start. AWC (11a)

Thermal Conductivity of Metals and Alloys (Über die Wärmeleitfähigkeit der Metalle und Legierungen) A. SCHULZE. *Die Wärme,* Vol. 56, Jan. 14, 1933, pages 17-20. Correlation of thermal conductivity λ of metals to temperature and connection between constitution of alloys and heat conductivity. Material in the soft, annealed state exhibits a larger λ than in the hard worked state. The decrease of the thermal conductivity of Fe due to Co, Ni, Mn, Al, Si is shown in a diagram. Isotherms of thermal and electric conductivity take about the same course in alloys. The latter decreases more radically than the former in systems built up
2 by a continuous series of solid solutions as in AuAg, CuNi, NiCr. The rule of mixture also holds for λ in heterogeneous alloys which is demonstrated by the ZnSn system (SnPb). Intermetallic compounds usually correspond to a peak value of λ. Two peaks occur in the CuPd system due to Cu_3Pd_2 and CuPd. Curves show the effect of Au, Zn, Pt, Pd, Ni, As and P on Cu and Au, Cd, Pt, Pd, Zn, Tl and Sn upon the thermal conductivity of Ag which proves the decrease of λ depends greatly on the alloying element. EF (11a)

Special Alloys (Speziallegierungen) *Zeitschrift für die gesamte Giessereipraxis,* Vol. 54, Sept. 3, 1933, pages 369-370; Sept. 17, 1933, pages 391-392. Review on composition, properties and application of non-ferrous alloys is continued in describing: (1) d' Arcet's gilding bronzes, distinguished from high
3 quality bronzes by high Zn content and correspondingly lower Cu and Sn content, (2) Delatot bronze, a Mn brass, 80% Cu, 18% Zn, 2% Mn, distinguished by good casting properties and excellent mechanical properties, (3) Delta metal, high alloy special brasses with good mechanical properties and high corrosion resistivity against seawater, (4) Durance bearing metal, a very hard white metal with 44.50% Sb, 33.30% Sn and 22.20% Cu, (5) Diamant bronze, an older type of Cu-Al-Si alloy, (6) German alloy, an Al sand cast alloy generally composed of 88% Al, 10% Zn and 2% Cu, (7) "Drittel" silver (66.6% Al, 33.3% Ag) formerly extensively used in ornament trade, (8) Dick's bearing bronze, a P rich bronze containing about 80% Cu, 10% Sb, 9.2% Sn, .8% P, (9) Dirigold, a series of Al or Cu-Al alloys used for art castings, (10) Dow metals in composition similar to German elektron metals, i.e. Mg alloys, (11) Dudley bearing metals,
4 P rich bearing metals as developed for Pennsylvania railroad, (12) Dudley antifriction metal, (13) Durievic bearing metals (Zn bearing metals), (14) Duralum, Al alloys alloyed with rather high contents of Mg and P-Cu according to patented method, average composition 79% Al, 11% Mg, 9.5% Cu, .5% P, (15) Duralumin, self-aging Al alloys. GN (11a)

Nickel-Silver (Neusilber) EDMUND RICHARD THEWS. *Chemisch-Metallurgische Zeitschrift, Die Metallbörse,* Vol. 74, Sept. 16, 1933, pages 1181-1182; Sept. 23, 1933, pages 1213-1214; Oct. 7, 1933, pages 1277-1278. Types of alloys discussed: 60-65% Cu, 13-35% Zn and 5-33% Ni. Intentionally added or present as impurities are Sn (0.1-4.0%), Pb (0.01-3.0%), Fe (0.1-
5 5.0%) and Mn (0.01-1.0%). Rising Cu contents improve the workability but impair the color, which is also detrimentally affected by working. Ni induces the silver-like color, increases strength, elongation, corrosion and heat stability and foundry difficulties, Zn renders the alloys cheaper and easier to cast. Difficulties arise above 31% Zn due to brittleness and reduced corrosion and heat resistance. The optimum Zn contents for sheet material change as follows with rising Ni contents:

60 Cu	10 Ni	30 Zn
58 Cu	18 Ni	24 Zn
54 Cu	30 Ni	16 Zn

Annealing temperatures for cold worked material should be higher than usually
6 applied (700-750° C.) Data on tensile strength and electric resistance in dependence on chemical composition are given. Influence exerted by Sn, Pb, Fe, Ag, Al, Cd, W and Co is taken up at length. The writer sees no benefit in the case of Ag, Cd, W, and Co. It is of interest to note that an alloy with 12% Ni and 1-1.5% Fe shows the same color as a 16% Ni alloy free from Fe. The opinions on the usefulness of Sn are still divided greatly. Pb improves the machineability and should be absent from material for rolling purposes. Al up to 2% improves the density (0.25-0.5% added) and the physical properties. The considerable foundry difficulties involved in the production of nickel silver are stressed and detailed instructions are furnished. Al is preferred in Germany for deoxidation, Mg in the U. S. A. Mg and Mn also eliminate S. EF (11a)

7 **Aluminum Congress (Aluminium Tagung)** *Chemisch-metallurgische Zeitschrift, Die Metallbörse,* Vol. 23, Oct. Sept. 30, 1933, pages 1246-1247; Oct. 7, 1933, pages 1278-1279; Oct. 14, 1933, page 1311; Oct. 21, 1933, page 1343. Following papers presented at the Aluminum Meeting at Hamburg, Sept. 14, 1933, are reviewed at considerable length. E. Roth. Aluminum, the German Metal (Aluminium, das deutsche Metall); E. Foerster, The present use and future importance of Al and its alloys with reference to shipbuilding and aircraft construction (Die bisherige Verwendung und die Zukunftsbedeutung des Aluminiums und seiner Legierungen im Bereiche der Schiff-sund Luftfahrtstechnik); Pabst, Construction Problems and Strength Research with Reference to Hydroplane Construction (Konstruktionsfragen und Festigkeitsforschung im Seeflugzeugbau; Hans Schmitt.
8 Electrical Oxidation of Al and its Alloys (Die elektrische Oxydation von Aluminium und seiner Legierungen); Dr. Herbig. Surface Protection of Light Metal (Oberflächenschutz von Leichtmetall) and H. Gervens, Joining Methods for Light Metals (Leichtmetall-Verbindungsarbeiten). EF (11a)

Hardenable Aluminum Casting Alloys (Ueber vergütbare Aluminiumgusslegierungen) E. SOEHNCHEN. *Die Giesserei.* Vol. 20, Mar. 17, 1933, pages 111-112. Experiments with hardenable Al alloys, Lautal, Y-alloy and a new type of Silumin were made to determine aging by measuring Brinell hardness. A natural aging after removal from the mold could not be stated with certainty. Slow drawing to 140° C. increased hardness in Silumin about 16%, in Y about 10%, in Lautal no definite
9 result was obtained. Quenching in cold water alone did not show an improvement in hardness, unless followed by artificial aging whereby an increase of 22% was found for Y-alloy, 35% for Silumin and 85% for Lautal (as compared to the "as cast" hardness). Y-alloy is superior to the others as it is insensitive to temperatures up to 250° C. Duration of annealing required to obtain the highest strength depends not only on the alloy but also on the grain size. Ha (11a)

The Viscous Properties of Extruded Eutectic Alloys of Lead-tin and Bismuth-tin. C. E. PEARSON. *Journal Institute of Metals,* Vol. 53, Dec. 1933, pages cci to ccxv, Paper No. 652. Extruded eutectic alloys of Pb-Sn and Bi-Sn were subjected to prolonged tensile stresses. They behaved in a viscous manner and the elongation at fracture was as great as 2000%. An apparatus was constructed for
10 holding the stress constant (actual stress, not stress calculated on the original area) and the rate of flow over long periods determined. Results proved that deformation took place at a uniform rate. The rate of flow was greatest for the freshly extruded rods. Flow figures and microexamination indicated that flow took place at the intercrystalline boundaries and that the smaller the grain size the greater the rate of flow for a given stress. 10 references. JLG (11a)

Revision of Atomic Weight of Tellurium. II. Synthesis of Silver Telluride (Revision des Atomgewichts des Tellurs. II. Synthese des Silbertellurids) O. Hoenigschmid. *Zeitschrift für anorganische und allgemeine Chemie,* Vol. 214, Oct. 7, 1933, pages 281-288. The atomic weight of Te was redetermined from a quantitative synthesis of Ag_2Te as 127.61 as referred to Ag = 107.880. Ha (11a)

Some Measurements of the Flow Pressure of Metals at Low Temperatures (Einige Messungen über den Fliessdruck von Metallen in tiefen Temperaturen) R. Holm & W. Meissner. *Zeitschrift für Physik,* Vol. 74, 1932, pages 736-739. Measurements were made at temperatures from 293° down to 20° abs. to determine the behavior of metals (Au, Pt, Ag, Pb, Sn, Cu) when a little steel ball was pressed against them until the metal began to flow. The flow pressure increased very greatly with decreasing temperature, most with Ag, least with Au. The previous mechanical working of the metal has a great influence on the flow pressure. Ha (11a)

The Atomic Weight of Uranium Lead (Ueber das Atomgewicht des Uranbleis) O. Hoenigschmid, R. Sachtlebe & H. Baudrexler. *Zeitschrift für anorganische und allgemeine Chemie,* Vol. 214, Sept. 2, 1933, pages 104-110. The atomic weight of Pb from U ores of the Belgian Congo was determined as 206.03 while that of ordinary Pb was checked again as 207.21. 7 references. Ha (11a)

Beryllium and its alloys (Le Glucinum et ses alliages) Jean Challonsonnet. *Aciers Spéciaux, Métaux et Alliages,* Vol. 8, June 1933, pages 166-179. In a more or less extended abstract of the book on Beryllium published by Siemens & Halske, Germany and translated in English by R. Rimbach, author reviews the existing knowledge on Be. GTM (11a)

Heat-Treatment of Beryllium Copper E. F. Cone. *American Machinist,* Vol. 77, Sept. 27, 1933, pages 620-622. Properties of Be-Cu alloys are discussed; precipitation hardening is particularly effective, improving elastic limit and tensile strengths in alloys containing at least 2% Be. Tables of properties of different compositions with their treatments and micrographs are given. Ha (11a)

Mechanical and Chemical Properties of Alloys of Al with Cr, Fe, Mg, Mn, Ti and V (Sulle propieta meccaniche, e chimische delle leghe di alluminio con cromo, ferro, magnesio, manganese, titanio, e vanadio) H. Bohner. *Alluminio,* Vol. 2, July-Aug. 1933, pages 193-208; *Metal Industry,* London, Vol. 43, July 14, 1933, pages 27-30; July 21, 1933, pages 56-58. Translation of an article in *Metallwirtschaft,* May 5 and 12, 1933. See *Metals & Alloys,* Vol. 4, Oct. 1933, page MA 308. AWC + Ha (11a)

Research in Electrotype Metals. Samuel Epstein. *Platers' Guide,* Vol. 29, Mar. 1933, pages 9-11. An abstract of an address. Composition of electrotype metal adopted by the Standardization Committee and that of the more generally used 94-3-3 alloy have no scientific basis. Increase in Sn or Sb or both might remove the alloy from the critical range. It is probable that "mottling" on solid areas in the outer surface of curved plates is due to the plates having been stretched beyond their elastic limit. Excessive plate shrinkage may be due to undue contraction in the metal in final crystallizing. Age-hardening in Pb-Sn-Sb alloys is encountered in electrotypes and no information is available to indicate quantitatively the rate and amount of this hardening. These problems are being investigated at Battelle Memorial Institute. WHB (11a)

Measurements of Electric Conductivities of Zinc-Cadmium and Lead-Antimony Systems with Consideration of Stable Equilibriums (Elektrische Leitfähigkeits messungen an Zink-Kadmium- und Blei-Antimon-Systemen unter Berücksichtigung stabiler Gleichgewichtseinstellungen) M. le Blanc & H. Schoepel. *Zeitschrift für Elektrochemie,* Vol. 39, Aug. 1933, pages 695-701. The specific electric conductivities were determined at different temperatures for the 2 systems which do not form compounds and have very limited ranges of solid solution. The deductions from electric measurements were confirmed micrographically. Ha (11a)

A Study of Al-rich Al-Cu-Si Alloys III. Chinyo Hisatune. *Japanese Journal of Engineering,* Abstracts, Vol. 9, 1933, page 69. Al-Cu-Si alloys containing up to 40% Cu and 8% Si were quenched from 450°-520° C. and found to be subject to aging at 100°-200° C. Tensile strength, Charpy impact strength (wrought and cast alloys) and impact hardness at 25°-500° C. showed marked gains due to artificial aging. The most suitable forging temperature proved to be 450°-500° C. Alloys containing over 4% Si and over 6% Cu were not suitable for forging. In summary: alloys with 4% Cu and 2-4% Si proved to be superior in many respects to the other Al-rich Al-Cu-Si alloys. WH (11a)

Aluminum Bronzes (Bronzes d'Aluminium) Léon Guillet. *Cuivre et Laiton,* Vol. 6, May 30, 1933, pages 237-238. A few general remarks on the development of Cu-Al alloys of which the one of 90% Cu and 10% Al was made as early as 1860. The advantages of these alloys are briefly set forth, particularly the improvement of mechanical properties by heat-treatment in alloys containing 9-16% Al. Ha (11a)

Dependence of Electric Resistance of Pure Metals on Temperature (Die Abhängigkeit des elektrischen Widerstandes reiner Metalle von der Temperatur) E. Grueneisen. *Annalen der Physik,* series 5, Vol. 16, Mar. 1933, pages 530-540. The formula $\rho = T\sigma\ [1 + \alpha_1\ T + \alpha_2\ T^2]$ represents the resistance very well for very low and very high temperatures if σ is taken as changing with the temperature. A relation was developed for σ and tables calculated which agreed well with measured values. Ha (11a)

Electric Properties of the Metals and Wave Mechanics (Les Propriétés Electriques des Métaux et la Mechanique ondulatoire) Léon Brillouin. *Revue Générale de l'Electricité,* Vol. 34, Aug. 12, 1933, pages 63-175; Aug. 19, 1933, pages 202-208. The mechanism of the passage of electricity through metal conductors is explained in the light of modern wave theory of electrons. The physical properties are discussed in relation to the crystal structure and the electric fields which act upon the lattice. 12 references.. Ha (11a)

Precipitation Hardening Nickel-Copper Alloys Containing Aluminium. D. G. Jones, L. B. Pfeil & W. T. Griffiths. *Institute of Metals,* Advance Copy No. 645, Sept. 1933, 14 pages; *Metal Industry,* London, Vol. 43, Sept. 22, 1933, pages 284-286. Alloys containing 10, 20, 30 or 45% Ni and as much as 4% Al were studied. Ha + JLG (11a)

Industrial Brasses (Les Laitons Industriels) M. Lencauchez. *Revue de Fonderie Moderne,* Vol. 27, Mar. 25, 1933, pages 81-89; *Cuivre et Laiton,* Vol. 6, July 30, 1933, pages 343-350. 3 types of brass are distinguished: (1) 60% Cu, 40% Zn, ordinary brass, (2) from 65/35 to 72/28, brass for cartridges and tubes, (3) from 80/20 to 90/10, half-red brasses. Other constituents, Fe, Ni, Sn, Pb, Al and Mn are added to obtain certain qualities desired for a definite purpose. Melting methods in various types of furnaces are described; the electric furnace is being employed to an ever increasing degree. Pouring methods of ingots for different purposes and sources of failures are discussed. Ha (11a)

Die Castings in Aluminum Bronze. H. Bentley. *Metal Industry,* London, Vol. 43, July 21, 1933, page 52. Die-cast Al bronze parts have proved very satisfactory in the motor vehicle industry; they are readily machinable, can be brazed and electroplated, and have an attractive, gold-like appearance. Sp. gr. is 7.5 against 8.5 of normal Sn bronzes; maximum strength is 37 tons/in.[2], yield point 15 tons/in.[2] and elongation 40%. Ha (11a)

Wiedemann-Franz Number, Heat Conductivity and Thermoelectric Force of Tellurium (Wiedemann-Franzsche Zahl, Wärmeleitfähigkeit und thermoelektrische Kraft von Tellur) C. H. Cartwright. *Annalen der Physik,* Series 5, Vol. 18, Nov. 1933, pages 656-678. A new method for measuring Wiedemann's number, heat conductivity and thermoelectric force is developed and tried on monocrystalline and polycrystalline Te. Heat conductivity at room temperature was found to be 1.5×10^{-2} watts/1 cm./1° C. and at the temperature of liquid oxygen 2.5×10^{-2} watts/cm./1° C. Ha (11a)

Progress in Light Metal Casting for High Stresses (Fortschritte im Leichtmetallguss für hohe Beanspruchungen) G. Sachs. *Zeitschrift Verein deutscher Ingenieure,* Vol. 77, Feb. 4, 1933, pages 115-120. The development of a hardenable Al casting alloy on an Al-Si basis is discussed. The eutectic Al-Si alloy must be refined with metallic Na in order to obtain a fine structure and to increase strength and elongation. This alloy is corrosion resistant. Cu-silumin is an Al-Si alloy with 0.8% Cu, and for very high-grade castings with 0.3% Mn in addition to counteract the Fe present in all Al-Si alloys. However, the Cu content reduces the elongation considerably and the corrosion resistance to a smaller degree. A refinable alloy (alloy Y) contains 4% Cu, 2% Ni and 1.5% Mg. The addition of Mg to Al-Si has the effect of making the casting insensitive to abrupt heat treatment, preventing cracks. The mechanical properties are improved, although the Mg content is not higher than 0.5%. Casting in metal molds produce better properties and greater density. The manner of melting, casting and molding has a great influence on the quality of the casting; slag must be prevented from getting into the casting, water must be absent from the furnace atmosphere, the temperature must be carefully controlled. The conditions are discussed and test results described. 15 references. Ha (11a)

Heat Loss and Temperature Distribution of Electrically Heated Wires (Über die Wärmeabgabe und Temperaturverlauf von elektrisch erhitzten Drähten) A. Farkas & H. H. Rowley. *Zeitschrift für physikalische Chemie,* Abt.B, Vol. 22, Sept. 1933, pages 335-343. The discontinuity of heat loss/temperature curves observed on electrically heated Ni wires during the catalytic activation of the p-H_2-transformation, has also been confirmed on Pt submitted to analogous testing conditions. This break cannot be ascribed any longer to sudden changes at the metal surface for instance to hydride formation as previously assumed. It is rather due to an uneven temperature distribution since the Busch stability condition has been upset. (*Annalen der Physik,* Vol. 64, 1931, page 401.) EF (11a)

Zinc in Lead Base Bearing Metals (Über Zink in Bleilagermetallen) K. L. Ackermann. *Metallwirtschaft,* Vol. 12, Oct. 27, 1933, pages 618-619. Small amounts of Zn added to Pb-Sb alloys form Zn_3Sb_2 which changes to coarsely crystalline ZnSb at lower temperatures. When Sn is present the structure is more complicated and secondary crystallization of free Zn takes place with lower Zn content than in the Sn free alloys. The hardness and elastic limit of compression are increased and the impact strength lowered by Zn additions to Pb-Sb and Pb-Sb-Sn alloys. The casting properties of bearing metals containing Zn are very poor and are worse with increasing Zn content. The addition of Cu, Ni, Fe, or As has a very bad influence on the casting properties. The hardness and elastic limit of compression of Pb bearing metals containing Cu is increased by the addition of Zn provided the Sb content is high. 7 references. CEM (11a)

Recent Developments in Bearing Metals. A. J. Murphy. *Metal Industry,* London, Vol. 42, May 19, 1933, pages 517-519; June 2, 1933, pages 565-569; June 9, 1933, pages 591-594, 599. A comprehensive review and survey is made of metals and alloys for bearing metals and the defects commonly met with. Many of the latter can be traced to errors in applying a metal rather than to incorrect compositions. Good adhesion of linings is of utmost importance, especially in severely loaded white metal bearings. Rolfe's and Stanton's methods of determining the force required to tear lining from shell are explained. Regarding compositions it is stated that Sn base alloys are superior mechanically, especially at higher temperatures, and the rate of wear is almost always less than that of Pb base metals; here the lubricant has some influence; also the friction coefficient is generally greater in Pb base alloys. These 2 white metals generally have a composition of 0-93% Sn, 0-80% Pb, 3-20% Sb, 0-10% Cu. Bahnmetall (Pb 98.66%, Ca 0.7%, Na 0.6%, Li 0.04%) is a hard intermetallic compound of Na and Ca in a background of practically pure Pb, has a Brinell hardness of 35 and does not lose hardness with temperature at the same rate as the Sn and Pb base metals. Good experiences in Germany have not been fully substantiated in England. Value of As as hardener seems to be doubtful, while Ni is beneficial apparently only above 0.5% to about 3%. Zn-base metals are similar to Sn bronzes rather than to white metal. Lately Cd-base alloys have been developed with up to 95% Cd and small amounts of other metals, usually Cu and Mg. These alloys have a Brinell hardness of 50 to 60 and work satisfactorily at pressures of 2500 lbs./in.[2] and speeds of 10-11 ft./sec. The possibilities of bearing alloys which do not require lubrication are discussed; porous and graphite bronzes have been developed, but they are very weak mechanically. A number of bearing testing machines are described. Ha (11a)

The Influence of Heat Treatment of Hardenable Aluminum Rolling Alloys on Their Corrosion Resistance (Zur Frage des Einflusses der Wärmebehandlung härtbarer Aluminiumlegierungen auf ihre Korrosionsbeständigkeit) H. Mann. *Oberflächentechnik,* Vol. 10, July 4, 1933, page 156; *Aluminium,* Vol. 15, June 30, 1933, pages 5-6. Rolled Al alloys like duralumin, when used in airplanes are heat treated so as to obtain highest possible strength; such heat treatment often influences the corrosion resistance unfavorably. Duralumin 681B and lautal VLW14 were investigated as to the way in which annealing from 460° to 540° C., quenching and storing at room temperature changes their behavior. Greatest corrosion resistance was found at 480°-510° C. for duralumin, 515°-520° C. for lautal. Cu-containing alloys of duralumin have a maximum of corrosion between 125°-150° C.; lautal is more sensitive than duralumin. The reason for the corrosive attack is seen in the $CuAl_2$ crystals which at temperatures over 150° C. are segregated at the grain borders and start intercrystalline decomposition of light alloys. Ha (11a)

On the Specific Heat of Copper from −78° to 0° C. S. M. Dockerty. *Canadian Journal of Research,* Vol. 9, July, 1933, pages 84-93. Continuation of recent work by Bronson, Chisholm, and Dockerty (*Canadian Journal of Research,* Vol. 8, 1933, 282-303) on specific heats of W, Mo, and Cu from 0° to 500° C. The adiabatic calorimeter used in these experiments is described in some detail. The equation previously given for the specific heat of copper contained only the first two terms of the Debye expansion and was found not to hold below −30° C. An equation, containing 4 terms of the Debye expansion, was found to fit the experimental curve from −78° to 500° C. with a maximum deviation of only about 0.05%. OWE (11a)

Wear in the Polishing of Plated and Other Surfaces. O. F. Hudson. *Institute of Metals,* Advance Copy No. 642, Sept. 1933, 6 pages; *Metal Industry,* London, Vol. 43, Sept. 22, 1933, pages 286-287. Wear of samples polished on parchment with MgO was determined by weighing before and after polishing. The materials tested included Pt, Pd, Pt plating on brass, Pd plating (soft and hard) on brass, Ni plating (soft and hard), and Ag plating. The rate of wear of Pd was about twice as great as that of Pt. Platings showed a higher resistance to wear than blocks of the materials. On the whole, the rate of wear (loss in thickness) of the precious-metal coatings was of the same order as that of Ni-plating. Ag plating was the least wear resistant of any of the coatings studied. No definite or consistent relationship between hardness and wear on polishing was revealed. Ha + JLG (11a)

Light metal rivets (Leichtmetallnieten) K. Guler. *Zeitschrift für Metallkunde,* Vol. 25, Sept. 1933, pages 214-217. Discussion of the behavior of high strength aluminum alloy rivets: duralumin, Avional (94.4% Al, 0.3-0.6% Si, 0.3% Fe, 0.5% Mn, 0.55% Mg, 3.8% Cu) and Anticorodal (97.25% Al, 1.0% Si, 0.3% Fe, 0.7% Mn, 0.65% Mg, 0.1% Cu). Duralumin of German specifications 681a and Avional were found to have high resistance to sea water corrosion whereas duralumin 681n corroded rapidly (shown by photographs). The tensile properties of Avional and Anticorodal are given in tables and graphs; also the hardening curves as measured by Brinell hardness, shearing strength, and tensile strength. Avional hardens on room temperature aging whereas Anticorodal must be artificially aged. RFM (11a)

Ferrous (11b)

E. S. DAVENPORT, SECTION EDITOR

Contribution to the Study of Hardness of Cast Iron (Contribution à l'Étude de la Dureté des Fontes) R. CHAVY. *Bulletin de l'Association Technique de Fonderie*, Vol. 7, Dec. 1933, pages 528-536. Means to obtain castings with any hardness between 120 and 300 Brinell are discussed. Martensitic cast irons with Ni between 2 and 5% and Cr between 0 and 1.5% (according to thickness) are either cooled in the mold or taken from the mold at high temperature (hardness > 340); these castings are made machinable (hardness 280-300) by annealing at about 500° C; annealing at 650°-700° C. softens them to 240-200 Brinell. Sorbitic cast irons with 2-3% Ni can be easily machined without any treatment, but are susceptible to quenching in still air or air-blast; hardness can be controlled between 280 and 350 by annealing. Over-tempered castings with 4-6% Ni and 3-5% Mn and a hardness of 120-160 can be hardened by heating at 600-650° C. after machining. Hardness measurements and various hardness scales are described. Ha (11b)

High Test Cast Iron (Das hochwertige Gusseisen). L. SCHMID. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 54, May 14, 1933, pages 194-198. Review of the present status of the production of high test cast Fe. The generally known methods, as the Lanz pearlite cast Fe, the Thyssen-Emmel method, the superheating of cast Fe according to Piwowarsky and Hanemann, the Corsalli method and the theories underlying these processes are considered, the improvement by alloying is referred to. GN (11b)

High-Sulphur Nitralloy for Free Machining. V. O. HOMERBERG. *Iron Age*, Vol. 130, July 21, 1932, pages 101-102; *Mechanical World & Engineering Record*, Vol. 42, Sept. 30, 1932, page 317. Machineability tests showed marked superiority of high-S steel over low-S steel. Author conducted tests on 2 steels of following compositions:

	Heat No. 33794	Heat No. 1530
Carbon	0.33	0.32
Manganese	0.48	0.47
Silicon	0.28	0.07
Aluminum	1.08	1.11
Chromium	1.20	1.29
Molybdenum	0.22	0.26
Sulphur	0.022	0.170
Phosphorus	0.017	0.018

Results show that reduction of area and elongation are somewhat higher for low-S nitralloy. Greatest difference is in impact properties. No marked difference in corrosion resistance was noted between the 2 steels subjected to water and salt sprays. Kz + VSP (11b)

New Magnet Steel. (Un nouvel acier pour aimant.) J. A. RABBIT & T. FUJIWARA. *Aciers Spéciaux, Métaux et Alliages*, Vol. 8, Mar. 1933, pages 84-88. The steel M.K. discovered by Mishima contains 3 principal elements: 10-40% Ni and 1-20% Al. Best results have been obtained with alloys containing 25% Ni, 10% Al, and 65% Fe. This alloy cannot be forged, it must be cast thus limiting its use. Coercive force of this steel is 650 gauss or approximately 9 times that of W steel. In as cast this steel, M.K. is only slightly magnetic, and in order to render it magnetic it must be annealed. The magnetic properties of this steel are not changed at elevated temperatures up to 700° C. GTM (11b)

Utilizing Cast Iron in Chemical Equipment. WILLARD H. ROTHER. *Chemical & Metallurgical Engineering*, Vol. 40, July 1933, pages 350-352. Some of the more general and useful properties of cast iron are discussed. PRK (11b)

Magnetic Properties of Iron-Cobalt-Tungsten Alloys. B. A. ROGERS. *Metals & Alloys*, Vol. 4, May 1933, pages 69-73. 15 references. The properties of 20 alloys of 0 to 90% Co, and 10 to 30% W, were investigated to determine, in part, a possible origin of coercive force. Preparation, treatment, and testing of the samples and the equipment are described. Graphs show curves of Young's modulus, Rockwell hardness, coercive force, electrical conductivity, density, flux density for H = 17,200 oersted, and residual magnetism, at aging temperatures from 0 to 1250° C. 8 micrographs show some of the structures obtained. The origin of coercive force is not revealed fully by the experiments unless it is assumed that the point where precipitation begins is where the electrical conductivity starts to increase. If so, the experiments suggest that the increase in coercive force depends on the initiation and development of a compound from a supersaturated solution, but there are at least 2 exceptions remaining. Other results: the conductivity increase of this type alloy obtainable by heat treatment is much greater than others, the increase as much as 800%. Coercive forces practically equal to Co steel have been found, but associated residual magnetism values are too low for practical use. Another alloy of controllable magnetism has been added to the list. Indicated by the results of a single composition, the dynamic Young's modulus is independent of the size of the precipitated particles. Generally, electrical conductivity and Young's modulus attain maximum values simultaneously, presumably when complete precipitation has been accomplished. WLC (11b)

Bituminous Rust Protective Coatings (Bituminöse Korrosionsschutzmittel) A. W. RICK. *Chemiker-Zeitung*, Vol. 56, July 27, 1932, page 590. For protective coatings in the chemical industry bituminous materials are used either as found in nature, or heated to separate from impurities, dissolved in a suitable solvent, or emulsified with water. The slow drying and hardening of bitumens is sometimes a disadvantage. The emulsions can be mixed with sand, cement, or gravel. Some of the coatings can be applied by spraying. The emulsions have the advantage of being tasteless and odorless. The thin bituminous paints are satisfactory for protection against neutral, alkaline, or weakly acid salts except $MgCl_2$. For weak acids thicker bitumens should be used and for strong acids only those which are applied after heating. CEM (11b)

Cast Iron as an Engineering Material. H. BORNSTEIN. *Metal Progress*, Vol. 23, May 1933, pages 19-23. Defines various types of cast iron. Strength classification of A. S. T. M. is given with a discussion of strength and composition. The use of only one of these in specifications is urged unless certain alloys are required to obtain properties not readily measurable. The various tests of cast iron are discussed and their usefulness in control. Microstructure, machinability, resistance to wear, heat and corrosion are discussed. The effect of mass upon the strength and the use of test specimens from the controlling section are discussed. WLC (11b)

Chromium-Nickel-Iron Castings from Sulphite Service. G. L. COX & F. L. LAQUE. *Paper Trade Journal*, Vol. 96, May 4, 1933, pages 30-36. 36 references. A report to Materials of Construction Committee, Technical Association of the Pulp and Paper Industry on the examination of 6 Cr-Ni-Fe castings taken from sulphite pulping service. Literature was reviewed and the findings are itemized in a summary. 5 of the 6 castings had failed in service. Photographs, service histories, and chemical analyses are given. Castings that failed were low in alloy content, generally deficient in Cr in relation to C. Although number of samples studied were not sufficient to determine any definite relationships between chemical composition and performance, specifications limiting significant elements are being drawn up. Metallographic examination indicates that corrosion was largely intergranular. Heat treatments, accelerated corrosion tests and metallographic examination of one of the castings indicate that inter-granular corrosion can be overcome by proper heat treatment to take into solution the intergranular constituents. CBJ (11b)

Handbook of Inorganic Chemistry (Handbuch der anorganischen Chemie) Vol. 4, Sec. 3, Part. 3, Leaflet 1. Edited by R. ABEGG, FR. AUERBACH & I. KOPPEL. S. Hirzel Verlag, Leipzig, 1934. Paper, 6¾ x 9½ inches, 626 pages. Price 58 RM. While this is a chemical handbook and the bulk of the volume deals with cobalt compounds, 104 pages, by A. Kurtenacker, assisted by R. Burian and L. Engel, deal with the metal. Another section of 76 pages, by J. Holluta, deals with its alloys. These sections contain 680 references. The physical properties of the metal are given, the magnetic and electrical data being most profuse. The purity of the so-called "pure" metal studied by various investigators has varied so much that the data are often discordant. Binary alloys with C, B, Si, P, As, Sb, Bi, S, Se, Te, Cu, Ag, Au, Be, Mg, Zn, Cd, Hg, Al, Tl, Ti, Zr, Sn, Pb, Cr, Mo, W, U, Mn and ternary alloys with Cr-C; Mo and several other elements especially Cu; W and other elements, are mentioned, with equilibrium diagrams when available, and references to literature. Stellite and Co-bonded tungsten carbide are given part of a page each. Alloys with Ni or Fe are not discussed in this volume. Little technical information is given, probably because Co as yet enters so few alloys of technical utility. Still it would seem that, even though high speed steel, permanent magnets and heat-resistant alloys were dealt with in other volumes, these uses might have had some discussion here rather than merely the barest mention. Nor is a clear picture of commercial smelting processes given. The chemical viewpoint so preponderates that the metallurgist will value the book chiefly for its references. H. W. Gillett (11b)-B-

Tool Steels (Die Werkzeugstähle) H. HERBERS. Heft 50 of Eugen Simon's Werkstattbücher. Julius Springer Verlag, Berlin, 1933. Paper, 6 x 9 inches, 60 pages. Price 2 RM. The definition of "tool" in this pamphlet is very broad, as it includes not only cutting tools of all types but also rolls, dies, etc. for hot and cold working, magnets, springs, ball bearings, etc., etc. Some 90 different compositions are listed, with suitable forging, annealing, hardening and tempering temperature ranges. The resultant strength ranges are also usually indicated. These data are given in compressed, schematic form, without much detailed discussion. The main object of the pamphlet is to list the uses to which each steel is commercially applied. This is also done in tabloid fashion. The lack of references makes it impossible to locate more detailed information on fine points not covered in the pamphlet. A large proportion of the steels listed contain W. H. W. Gillett (11b)-B-

Austenitic Cast Irons. *Mechanical World & Engineering Record*, Vol. 92, Aug. 19, 1932, pages 176-178. When using 20-25% Ni; 1½-7% Cu; 5% Mn; 5-6% Cr—in special cases 15%—it is possible to obtain cast iron highly heat and corrosion resistant, non-magnetic and with useful electrical properties. Their strength is often as high as that of good-quality cast iron, they are tough and have a measurable ductility. These irons offer no special foundry difficulties, and the castings are readily machinable, and can be welded. Corrosion tests and electrical and magnetic characteristics are presented in tabular form. Kz (11b)

A Steel with Iron Fibres. *Machinery*, London, Vol. 40, May 12, 1932, page 165. Calls attention to steel made by embedding strands of Lowmoor iron in steels, thus combining the fibrous toughness of iron with the strength of steel. It has a tensile strength of about 24 tons/in.² and can be forged and welded. Kz (11b)

New Tool Steel Contains Molybdenum and Tungsten. *Iron Age*, Vol. 129, June 9, 1932, pages 1252-1253. A cutting steel in which Mo replaces W but which in its finished form is similar to the more common high speed steels. It was developed by the Universal Steel Co., Bridgeville, Pa. and the Cyclops Steel Co., Titusville, Pa. It is known to the trade as Mo-Tung. Many Mo cutting steels have been produced the last 25 years, but results have been quite variable. A definite % of W is present in all Mo-Tung steels. In annealed condition the new steel has a sp. gr. of 7.95. Heat treatment is the same as is employed for W high-speed steels of 18-4-1 type, except that lower temperatures are used. Satisfactory hardening accomplished on small tools at 2150° F. and on large tools at 2200° F. Mo-Tung tools are tempered by reheating from 950 to 1100° F. Forging is carried on at temperatures of 1900 to 2050° F. VSP (11b)

Specifications for Cast Iron Pipe. *Industrial Standardization*, Vol. 4, Mar. 1933, page 55. A tentative draft of a procedure for test of pipe other than pit cast was completed and adopted by the Executive Committee. Kz (11b)

Observations on the Effect of Normalizing Medium Manganese Steels on the Microstructure and Physical Properties. C. R. AUSTIN. *Transactions American Society for Steel Treating*, Vol. 21, May 1933, pages 435-462. Paper presented at Buffalo Convention, Oct. 1932. Data from a study of effects of various normalizing treatments on microstructure and mechanical properties of a 1.5% Mn, 0.40% C steel are presented. The marked improvement for double normalized steel over "as rolled" and ordinary normalized steel is shown by micrographs, tensile strength, endurance limit and Izod impact test results. The treatment is heating for 30 min. at 800°-850° C. and air cooling, then heating to 750° C. and air cool. Large grain size and banded structure are eliminated by this treatment. Structure of these steels is suggested as being sorbitic rather than pearlitic and high strength is due to this sorbitic structure. An appendix gives data on a 1.8% Mn, 0.63% C steel to show the profound effect of slight increases in the Mn and C of these steels. Micrographs show unsatisfactory effect of normalizing this steel at 750°-1000° C. Low Izod impact and computed tensile strength values after normalizing and tempering indicate need for careful study of analysis of these medium Mn steels before adopting for a particular service. Includes discussion. WLC (11b)

Chrome-Nickel Steel for Navy Cast Steel Anchor Chain. T. N. ARMSTRONG. *Iron Age*, Vol. 131, Jan. 12, 1933, pages 100-101, adv. sec. page 10. Describes manufacture, properties and heat treatment of a new type of alloy steel for steel anchor chains. They were first produced from a 1.5% Mn, 0.30% C steel as recommended by the National Malleable & Steel Castings Co. After experimenting the navy yard changed the composition to a steel similar to S. A. E. steel No. 3135, containing approximately 0.35% C, 0.80% Mn, 1.5% Ni and 0.6% Cr. Includes table giving average results of some of the heat treatments. VSP (11b)

Carbides in Carbon-Containing Alloys of Tungsten and Molybdenum with Chromium, Manganese, Iron, Cobalt and Nickel. (Carbide in kohlenstoffhaltigen Legierungen von Wolfram und Molybdän mit Chrom, Mangan, Eisen, Kobalt und Nickel.) V. ADELSKOELD, A. SUNDELIN & A. WESTGREN. *Zeitschrift für anorganische und allgemeine Chemie*, Vol. 212, June 20, 1933, pages 401-409. An X-ray analysis of C containing alloys of W with Cr, Mn, Co and Ni, and of Mo with Fe, Co and Ni has shown the double carbides of the same type as Fe_3W_3C occurring in high-speed steels also occur in the systems Co-W-C, Ni-W-C and Fe-Mo-C. The stability of the carbides Fe_3W_3C, Co_3W_3C and Ni_3W_3C seems to decrease from Fe to Ni. In Co-Mo-C and Ni-Mo-C no carbides of this type could be found, very likely because of their disintegration during cooling on account of low stability. W-containing double carbides disintegrate when heated to high temperatures and form WC. Ha (11b)

Tensile Properties and Carbon Content in Low Carbon Steel. ITSUJI ADACHI. *Suiyokwai-shi*, Vol. 7, Nov. 25, 1932, pages 194-197. Author examined tensile properties of steel whose C was lower than 0.2%, and ascertained that following formula was applicable to such low C steel. Tensile strength = 0.7C + 30 where C = percent C × 100. In steel containing C lower than 0.15%, finishing temperatures of hot rolling have scarcely any influence on tensile strength and elongation under ordinary rolling operation. HN (11b)

Fabrication of 18-8, and 15-10 in England. J. A. McWilliam. *Metal Progress,* Vol. 23, Jan. 1933, pages 33-36. Fabrication methods used in England for 18-8 and 15-10 Cr-Ni alloys are described. The 15-10 alloy is as much used as the 18-8 there. Comparison of the mechanical properties of martensitic and austenitic alloys is made in a table. Intercrystalline corrosion is prevented by the addition of W, and sometimes Ti also to avoid heat treatment after welding. Hot work is done between 2100° and 1740° F., reheating to 2100° and quenching. Hot working, welding, riveting and machining methods are described. Cutting data for light and heavy work are presented in a table. Proper conditions for drilling and tapping are also tabulated. A number of applications of these steels are cited. WLC (11b)

The Properties of Some Copper-Bearing Steels. Part I. K. G. Lewis. *Carnegie Scholarship Memoirs, Iron & Steel Institute,* Vol. 21, 1932, pages 87-110. Previous investigations on amount of Cu that Fe and steel will dissolve, influence of C on this amount, and effect of Cu on critical points are discussed. Importance of Stead's work is emphasized. Experiments on 15 Cu-bearing commercial steels of various analyses for critical points, microstructure, mechanical properties, and forging and drawing qualities are presented. Results agree with certain previous investigators, but are inconclusive in general. Increased hardening effect, good forging and welding properties of low C Cu-bearing steels are shown. Critical points are definitely lowered by Cu. Corrosion tests (sea air), on same steels are being carried out at present. Effects of Mo and Cr on Cu-bearing steels are noted in an appendix. 80 references. WLC (11b)

Trends in Alloy Steel Metallurgy. M. J. R. Morris. *Iron Age,* Vol. 130, Sept. 22, 1932, page 463. Most important advances, according to the author, have been made along lines of finer quality of existing analyses, with consequent closer control of grain characteristics and of cleanliness. Alloy development is broadening and return of business volume will make this trend more apparent. Outstanding specific development during past year has been the increased use of 3½% Ni steel with Mo. Broad market for rustless steels. VSP (11b)

Valve Steels for High-Speed Oil Engines. R. Paterson. *Mechanical World & Engineering Record,* Vol. 93, May 19, 1933, page 478. Composition and heat treatment of a valve steel depends upon the temperature at which the valve has to work. The manufacturing process also affects choice, since, for example, a good forging steel may not be suitable for welding. The favorite type of steel is oil-hardened Si-Cr steel containing 2-4% Si, 6-10% Cr, 0.4-0.5% C, and a maximum of 0.3% Ni. W, in quantities up to 3.5% is becoming more common. Ni-Cr steels are characterized by a high tensile strength at elevated temperatures and certain water-hardened types are used at temperatures in excess of 900° C. This steel contains 15-28% Ni, 14-15% Cr, 1.75-2.0% Si and 3.5% W. Increased tensile strength at high temperatures is assisted by the inclusion of 0.75% Mn—i.e., twice as much as is found in Si-Cr steels. V steels show a much lower tensile strength at working temperatures than do Ni-Cr steels, despite the inclusion of 1% Ni, 0.55% Mn, and 5% W. Cr, in small quantities tends to clean up the steel, and Mo insures freedom from temper brittleness. After forging, the valves are annealed from 600°-800° C. to improve the machineability, and subsequent to machining operations are hardened at 850°-1100° C., and tempered at 600°-750° C. Properties and heat treatment of valve steels are presented in a table. Kz (11b)

Crankshaft Steels for High-Speed Oil Engines. R. Paterson. *Mechanical World & Engineering Record,* Vol. 93, Apr. 21, 1933, pages 389-390. Ni toughens the steel but also hardens it, thus giving good wearing properties without an appreciable increase in brittleness. Cr acts as a purifier, giving fineness of grain and improved structure, which results in a greater impact resistance. Inclusion of 0.4-0.6% Mo insures freedom from temper-brittleness. The C content of Ni and Ni-Cr steels is lower than in V steels. Strength of V steel is adjusted by 0.65-0.9% Mn additions. The tensile strength of 50-65 tons/in.^{2} has been increased to 100 tons ultimate tensile strength in some oil-hardened Ni-Cr steels of 0.8-1.2% Cr content while the air-hardened steel of similar strength shows up to 1.7% Cr. Cr-V steels are not so fool proof as the C-V brands, and need more care in their treatment. Recent practice tends towards the use of nitralloy steel and the introduction of a small amount of W into a Ni-Cr-Mo alloy of 2.5% Ni, 1.0-1.25% Cr, 0.3-0.35% Mo, 0.85-1.0% W. An increase in tensile strength of this steel without any reduction in ductility, can be obtained with a higher forging temperature and lower annealing and tempering temperatures. Analyses, properties and heat treatment of crankshaft steels are presented in 4 tables. Kz (11b)

Electric Properties of Iron-Nickel Alloys over a Large Temperature Interval. (Propriétés Electriques des Alliages de Fer et de Nickel dans un Large Intervalle de Températures.) P. Chevenard. *Revue Générale de l'Electricité,* Vol. 33, June 10, 1933, pages 759-760. See *Metals & Alloys,* Vol. 4, July 1933, page MA 206. Ha (11b)

Researches on Steels and Forgings for Greater Density, Machinability and Durability. F. W. Cederleaf & W. E. Sanders. *Transactions of American Society of Mechanical Engineers,* Vol. 54, Oct. 15, 1932, *Machine Shop Practice Section,* pages 127-138; *Machinery,* Vol. 39, Sept. 1932, page 34. Details are given of a research made to find means of improving machinability of gear blanks upset from bar steel, as well as durability of finished gear after heat treatment. It was found that a steel of coarse grain upsets into a denser product than one of fine grain; the denser material is more readily machined and with less tool wear. Specifications for suitable steels are derived from these results. 11 references. RHP + Ha (11b)

Basic Bessemer Steel. V. Harbord. *Railway Engineer,* Feb. 1933, pages 34-35. Referring to a previous article "The Renaissance of Basic Bessemer Steel (*Railway Engineer,* Jan. 1933, page 2.), Harbord holds that the speed at which it is necessary to operate the basic Bessemer process is responsible for the lack of chemical control. Even with experienced operators there is always a risk of either overblown steel or steel of high P content being produced resulting in either case in steel of unreliable and inferior quality. The possibility of a high P content is further increased in the production of rails on account of the high C content required in the steel as there is a greater tendency for P to pass back from the slag into the steel during recarburization than with steel made by the open hearth process. Although excellent rails can be produced from basic Bessemer steel, the British Standards Institution removed the latter from their specification since the rails proved to be less reliable than rails produced by the open-hearth process. The chief reason for the discontinuation of the Basic Bessemer steel manufacture in England was that it was becoming more and more difficult to obtain sufficiently high P raw material. The re-introduction of basic Bessemer steel (Corby) should be restricted to those mild steel products in which variations in the physical properties are not serious, i.e. mainly low C semi-finished products such as tube strip, sheet bars and billets for drawing into common wire. WH (11b)

Standard Steels for Nitriding. F. Giolitti. *Metal Progress,* Vol. 23, May 1933, pages 39-41. Comments on use of 3 varieties of nitriding steels produced in France of following compositions, Cr 1.70%, Mo 0.45%, Al 1.10%; Cr 1.45%, Mo 0.30%, Al 0.30; and Cr 2.30, V 0.15% without Al. WLC (11b)

Composition Limits for Alloy Steels. F. Giolitti. *Metal Progress,* Vol. 24, Aug. 1933, pages 41-42. Amounts of various elements considered as rendering a steel an alloy steel of that element in the view of Italian metallurgists are given and discussed. WLC (11b)

Eutectic Cast Iron. (Fontes Eutectiques.) L. J. Gouttier. *Revue de Fonderie Moderne,* Vol. 26, Nov. 25, 1932, pages 432-433. The nature of eutectic cast irons of which there exist an infinite number according to the composition and presence of C, Si and P, is explained on the basis of the theory of Osann, and the chart developed by the latter showing the proper amount of C and Si for a casting of a given thickness is reproduced. Ha (11b)

Chromium Steels Improved by Nitrogen. Russell Franks. *Iron Age,* Vol. 132, Sept. 7, 1933, pages 10-13. N is particularly effective in reducing grain size and improving physical properties of cast steel containing 25% or more of Cr. While N improves strength and toughness of steels containing even 30% Cr or more, Cr should be about 25% to obtain strong and tough castings with good heat and corrosion resistance. Successful commercial heats proved the desirability of high N contents in these steels, particularly in castings susceptible to cracking. N also improves high Cr wrought steels. N tends to retard development of brittleness in low C steels containing over 20% Cr. Effect of N on high Cr-low Ni steels is discussed. N has a detrimental effect on wrought Cr-Ni steels, decreased stability being noted at elevated temperatures. If held at temperatures between about 600 to 900° C. these wrought Cr-Ni steels suffer great decrease in toughness. Tabulates results of tests and includes a number of references. VSP (11b)

High Test Cast Iron. R. S. MacPherran. *Foundry,* Vol. 60, Aug. 1932, pages 26-27, 61-62. (Second installment.) Meehanite cast Fe is made in cupola, electric and air furnace, using calcium silicide. When made in cupola 75% steel scrap is used. Ermanite is made in air furnace of reverberatory type. This Fe is easy to machine and is slightly tougher than gray Fe. The practice of Allis-Chalmers Co. is to use a mixture of 60% steel. Analysis of resulting Fe: C 3.00-3.20%; Si 1%; S 0.120%; P 0.30%; and Mn 0.80%, being used for castings requiring good wearing surfaces. Mo, when used is added to stream of Fe in spout in form of ferro-molybdenum. A number of American foundries make an intermediate Fe from charges containing about 50 to 60% steel. Gives table showing results of physical tests from standard arbitration test bars covering a month run. VSP (11b)

Mechanical Properties of Rolled Steel. Influence of Rolling Operation. Tetsuyuki Fujimura. *Suiyokwa-shi,* Vol. 7, Nov. 25, 1932, pages 148-155. Influence of rolling operation upon mechanical properties of steel containing 0.13-0.18% C was examined. Finishing temperature has a great influence upon tensile strength and elongation. The smaller the finished materials are in size, the greater the influence of rolling operation. When cooling is performed with water spray before finishing, increase of 8-15 kg./mm.^{2} in strength and decrease of 8-18% in elongation are observed. If finished material is cooled, strains and irregularities in elongation are brought forth. Due to decarburization of surface layer, black materials are always low in strength and high in elongation, compared with those of machined specimens. HN (11b)

Nickel Steels Resist Embrittlement. H. J. French & C. M. Schwitter. *Iron Age,* Vol. 130, July 14, 1932, pages 51-53, adv. page 18. Discusses some of the less recognized characteristics of low C-Ni alloy steels which make them valuable in boiler construction. Results show that increase in Ni content in low C steels (1) reduces aging embrittlement, such as is shown by impact or slow bend tests on notched bars, (2) reduces grain size which can develop on recrystallization, and (3) raises the temperature at which strain markings of maximum intensity are observed in strain-etch tests. Appreciable benefits are derived with addition of about 2% Ni. Improvements increase with increase of Ni content up to 50%, the limit investigated. VSP (11b)

On Hardness, Structure and Machinability of Cast Iron. (Ueber Härte, Gefüge und Bearbeitbarkeit von Gusseisen.) Aug. Fischer. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 54, Aug. 6, 1933, pages 318-320. Merely the hardness permits no conclusions on wear resistance and machinability of cast Fe; structure of the matrix is of prime influence. Identical hardnesses of various cast Fe pieces may be obtained with most variable structures yet showing variable machinability and resistance to wear. When higher resistance to wear and better machinability is required than is possible with a pearlitic matrix the pearlitic structure should be transformed to a martensitic-sorbitic one. This can be attained by adding 2-5% Ni and about .5-1.5% Cr while simultaneously decreasing C, Si and Mn. Such a cast Fe in which free cementite is present is easily machinable. By subsequent heat treatment (1) hardening from 700°-900° C., according to Ni content in oil or air or slow cooling in still air in order to suppress formation of sorbitic-pearlitic structure and (2) subsequent annealing hardness and resistance to wear are increased considerably, amounting to about 2-3 times that of pearlitic high test cylinder cast Fe. GN (11b)

Internal Friction in Iron and Iron Alloys. R. H. Canfield. *Transactions American Society for Steel Treating,* Vol. 20, Dec. 1932, pages 549-576. The author describes a method of determining values for internal friction in tubular specimens which are made the elastic control of a large torsion pendulum maintained in a steady state of vibration by electromagnetic forces. These forces are estimated accurately from the ammeters in the electrical circuit. The half width of the hysteresis loop, f', called the friction stress is determined from the currents flowing in the fixed and movable electromagnets and the section modulus of the specimen, the stress amplitude or elastic stress, f, times the internal friction equals f'. The author shows f-f' curves for pure Fe in various conditions of strain, and for certain steels. The form of the curve is influenced by (1) space lattice of the metal, (2) grain size of the metal, (3) the amount of intergranular strain or hardening and its character, (4) effects of plastic deformation or fatigue, which disappear with lapse of time, and (5) effects due to surface conditions, and stress concentrations due to internal cracks or other conditions extraneous to the true properties of the metal. Internal friction is discussed as a desirable physical property and in its relation to fatigue. A table gives internal friction values for Armco Fe, C steels with 0.27% to 1.17% C, free machining stainless steel in 3 conditions, duralumin and cartridge brass. In discussion G. R. Brophy of General Electric reports that he has obtained results showing that there is no relation between endurance limits of notched and unnotched specimens and internal friction, nor does the reduction due to the notch bear any relation to the internal friction. 10 references. WLC (11b)

Damping Capacity of Steels and Correlation with Other Properties. G. R. Brophy. *Iron Age,* Vol. 130, Nov. 24, 1932, pages 800-802; Dec. 29, 1932, page 989, adv. sec. pages 10, 12. Damping capacity is measured by noting decrease in amplitude per cycle at various stress points on damped vibration amplitude curve and expressing this in % amplitude. Presents result of study of influence of temperature, cold work and composition on damping capacities of several steels, and to show that general correlation with creep does exist, but that correlation with Charpy impact results are doubtful. Truly elastic material should have zero damping capacity, but so far such material does not exist. Damping capacities were determined on Foeppel-Pertz machine. Quenching lowers damping capacity and the harder a steel becomes the more it is lowered. Chevenard's work shows that chemically simple steels might have higher damping capacities than those more highly alloyed and that this is especially true if added elements form a solid solution. Annealed steel has greater resistance to creep over all temperature ranges than heat treated steel. Damping capacity is of real importance in machines subject to vibrations in that it controls stresses tending to be set up by them. Includes number of graphs and tabulates results of tests. VSP (11b)

Contribution to Study of Low and Very Low Carbon Cupola Cast Irons. (Contribution à l'Étude des Fontes à Basses et à très Basses Teneurs en Carbone Réalisées au Cubilot.) Georges Delbart & Edgar Lecoeuvre. *Bulletin de l'Association Technique de Fonderie,* Vol. 16, Sept. 1932, pages 535-581. Presented at World Foundry Congress, Paris, Sept. 1932. Cast irons with C content from 1.70 to 2.50% were melted in a cupola. Plain coke, with regulation of blast and composition and frequency of charges, gave best results. Low C cast irons with high Si and over 1.50% Mn gave sound castings, which, after heat treatment, had excellent physical properties and were machinable. WHS (11b)

Ferrosilicon. (Contribution a l'étude des ferrosiliciums.) H. Delomenie. *Journal du Four Electrique,* Vol. 42, Aug. 1933, page 278. Brief description of the properties of ferrosilicon. JDG (11b)

A New Highly Corrosion and Heat Resisting Special Steel. (Ein neuer hoch korrosions- und hitzebeständiger Sonderstahl.) F. HENGLER. *Maschinenkonstrukteur-Betriebstechnik,* Vol. 66, June 10, 1933, pages 81-83. The new steel marketed under the trade name "Furodit" possesses high resistance against corroding media and scaling at high temperatures and is tougher than Cr steels for this purpose. Therefore, the steel can be worked easily at room temperature. Furodit S is used for corrosion proof parts which must be workable at room temperature, Furodit Z for scale proof parts. The following table shows the weight loss due to scaling in g./hr. and m.^{2} surface:

	At 800° C.	1000° C.	1200° C.
C steel	43	200	526
Fe-Pt	2	17	310
Furodit Z	0	1	6

GN (11b)

Recent Progress in Alloy Steels (Neuere Entwicklung auf dem Edelstahlgebiet) E. HOUDREMONT & H. KALLEN. *Zeitschrift Verein deutscher Ingenieure,* Vol. 77, Feb. 25, 1933, pages 191-195; *La Revue Industrielle,* Vol. 63, Aug. 1933, pages 408-418. Alloy steels are classified as tool steels, structural steels and steels with special physical and chemical properties. The characteristic effects of alloying elements are discussed. Tool steels are usually made in electric furnaces of moderate capacity; they contain C with small additions of Cr, V and Co. Structural steels are mainly steels with Cr and Ni to which 0.5 to 1% Mo has been added recently. Magnet steels usually have 1% C and 9% Cr with a Co content varying from 3 to 36%; W-Co alloys are used for this purpose. Heat-resisting steels have a base of Cr, Cr-Si, Cr-Al, Cr-Ni with addition of Mo according to whether they have to resist high temperature, furnace gases, etc. Cr-Al alloys, for instance, do not scale up to 1300°C. Cr-V steels are used for springs on account of their fine grain. A large number of tables giving the composition, behavior and physical properties of various alloy steels are included. FR+Ha (11b)

The Effect of Manganese Content on the Properties of Medium Carbon Steel. C. NORMAN BOWERS. Graduate Thesis, University of Pittsburgh, 1932, 70 pages. 3 groups of 0.35-0.45% C steels containing approximately 0.80, 1.35, and 1.55% Mn were subjected to tensile, hardness and impact tests, and fatigue tests in air, salt water, and salt water saturated with H_2S. Longitudinal and transverse sections of the test rods were examined metallographically. Increased Mn slightly lowered the ductility and resistance to impact, but increased the yield point, tensile strength, and hardness. Fractures caused by static and dynamic stresses were fundamentally the same. There was a relation between the tensile strength and air fatigue resistance, but no proportionality between the tensile strength and fatigue resistance under corrosive conditions. Increased Mn content gave greater fatigue resistance in air, and lower fatigue resistance under corrosive conditions. The endurance limit in salt water saturated with H_2S was much lower than in salt water alone. There was no apparent relationship between the fatigue limit in H_2S-saturated salt water and other physical properties. CWS (11b)

Phoenix Rapid Machining Steel. *Automobile Engineer,* Vol. 23, Sept. 1933, pages 333-334. Gives uses, properties, and photomicrographs of this steel made by the Steel, Peech and Tozer branch of the United Steel Companies, Ltd.

Mechanical tests	Mild steel black bar ½ in. dia.	Phoenix black bar 31/64 in. dia.
Yield point, tons/in.^{2}	19.35	19.40
Maximum stress, tons/in.^{2}	29.83	28.38
Elongation % in 2 in.	41.5	39.0
Reduction of area %	66.32	58.96
Yield ratio	64.0	68.0
Izod, ft. lb.	94,90,92	68,64,64

Cutting speeds of 200 ft. per minute with a ½ in. cut is used for rough turning; finishing cuts are done at speeds up to 400 ft. per minute. RHP (11b)

Develops Manganese-Chrome-Vanadium Steel for Automotive Forgings. H. T. CHANDLER & C. N. DAWE. *Steel,* Vol. 93, Sept. 25, 1933, pages 23-26, 30. Steel designated as "Normalloy," containing 0.27-0.45% C, 1.05-1.30% Mn, 0.08-0.11% V, 0.30-0.40% Cr, 0.05% max. S, and 0.04% max. P, has been developed as an intermediate alloy steel for "medium-stressed" forgings such as crankshafts, connecting-rods, steering arms, universal joint parts, axle shafts, etc. Higher C type is especially suitable for normalized forgings. Total alloy content is sufficient to assure ample tensile and dynamic properties and the alloying elements are so proportional as to give the optimum balance between moderate cost and adaptability to forging, heat treating, and machining. Content of V is sufficient to confer many of the well-known properties of V steels. The steel is essentially a H_2O quenching steel throughout the range of composition given. Quenching temperatures vary from 1525° to 1600°F., depending upon C content and thickness of section. Microstructure is exceedingly fine in both the normalized and quenched condition, and is uniform from melt to melt and throughout a wide range of sections. When simply normalized, the physical properties equal or exceed those of quenched and tempered C steel of the S.A.E. 1040 type. In the manufacture of normalized crankshafts, warpage, straightening operations, non-uniform hardening, and other difficulties incident to quenching have been eliminated by the use of this new steel. As examples of the physical properties which may be developed, a 1-in. round bar with 0.27% C, H_2O quenched and tempered at 1100°F., had a yield-point of 110,000 lbs./in.^{2}; tensile strength, 117,000 lbs./in.^{2}; elongation in 2 in., 24%; reduction in area, 66%; Brinell hardness, 235; Izod value, 103 ft.-lbs. Properties of a normalized crank-shaft with 0.40-0.45% C were: yield-point, 70,000 lbs./in.^{2}; tensile strength, 109,700 lbs./in.^{2}; elongation in 2 in., 20%; reduction in area, 53%; and Brinell hardness, 221. MS (11b)

Develops Nickel-Chrome-Molybdenum Steels for Heavy-Duty Forgings. M. R. CHASE. *Steel,* Vol. 92, May 15, 1933, pages 23-25; May 22, 1933, pages 23-25. A. Finkl & Sons Co. has developed a series of Ni-Cr-Mo steels which have high physical properties in large sections, harden uniformly from a wide range of temperatures, withstand high drawing temperatures with little loss in strength, can be machined at higher hardnesses, show little distortion in heat treating, and appear to be free from temper brittleness. Type 1, containing 0.30-0.35% C, 0.55% Mn, 0.75% Cr, 1.50% Ni, 0.25% Mo, and 0.25% Si, is used in small and medium-size forgings ranging from 1 to 3 in. in section, which can be quenched and drawn. Properties of a test-piece cut from a midway point in a 13¼-in. diameter hydraulic press rod were: tensile strength, 114,000 lbs./in.^{2}; yield-point, 92,500 lbs./in.^{2}; elongation in 2 in., 19%; and reduction in area, 52%. Type 2, containing 0.35-0.45% C, 0.55% Mn, 0.75% Cr, 1.50% Ni, 0.25% Mo, and 0.25% Si, is intended for medium-size forgings which can be quenched or normalized and drawn. Slightly higher physical properties can be developed in this steel in medium sections than in the same section from type 1. Type 3, containing 0.50-0.60% Cr, 0.55% Mn, 0.75% Cr, 1.50% Ni, 0.30% Mo, and 0.25% Si, was developed for large forgings which can be quenched and in which deeper hardness penetration is desired. It is also intended for large forgings which cannot be quenched or on which quenching is not desired. In the latter case the steel is used in the annealed or normalized and drawn condition. It has found wide use in die-blocks. A normalized and drawn crank-shaft of this steel gave the following properties when tested midway of the 17-in. section: Tensile strength, 120,000 lbs./in.^{2}, yield-point, 90,500 lbs./in.^{2}, elongation in 2 in., 20%; reduction in area, 42%. Type 4, containing 0.50-0.60% C, 0.55% Mn, 0.80% Cr, 1.50% Ni, 0.75% Mo, and 0.25% Si, was developed for specialty uses on small and medium-size sections. It is a full air-hardening steel, but may be oil quenched if desired. Hardness of 85 scleroscope, 652 Brinell, can be obtained by either treatment. MS (11b)

Copper as an Alloy in Steel and Iron. E. F. CONE. *American Machinist,* Vol. 77, Oct. 25, 1933, pages 681-683. The beneficial effect of Cu as an alloying element in steel is described; 1% is about the practical upper limit in ordinary steels; no appreciable improvement results from larger amounts. Cu makes cast Fe close-grained and increases its corrosion resistance. "Ni-resist" cast Fe
1 contains about 6% Cu with 14% Ni and 2-5% Cr. Precipitation hardening is increased by Cu; the yield point can be raised from 15000 lbs./in.^{2} in ordinary alloys to 30000 lbs./in.^{2} by additions of Cu without quenching treatments. Recent investigations involving higher percentages of Cu are discussed. Ha (11b)

Correlation between Thermal Stresses and Tensile Properties of Steel (Zusammenhang zwischen Wärmespannungen und Festigkeitseigenschaften von Stahl) H. BUCHHOLTZ & H. BUEHLER. *Archiv für Eisenhüttenwesen,* Vol. 6, Feb. 1933, pages 335-340. Thermal stresses can be caused in transformation-free materials by rapid cooling (quenching of steel). Under similar cooling conditions, the magnitude and distribution of stresses depends mainly on the tensile properties, especially the proportional limit of the material. The influence of cooling conditions, such as
2 quenching temperature, heat conductivity and specific heat is determined by measurements of the distribution of stresses. If the cooling speed is sufficiently great the compressive stresses in the marginal zones may exceed the proportional limit in low-tensile materials, so that the area in which stresses occur and the tensile stresses in the core are increased. Ha (11b)

The Development of Magnetic Sheet Steels. W. E. RUDER. *General Electric Review,* Vol. 36, Sept. 1933, pages 406-408. The first great advance was the addition of Si to Fe which resulted in halving the losses and in producing non-aging characteristics. Grain size was controlled in order to procure a uniform sheet. Study of orientation of crystals has resulted in the development of methods of rolling which control the physical condition of the sheet. Vacuum fusion and electric arc and induction furnaces permit control of impurities. Annealing condi-
3 tions for the removal of mechanical strains have been improved. CBJ (11b)

Non-Oxidizing Steels (Les Aciers Inoxydables) MOREAU. *Usine,* Vol. 43, Jan. 11, 1933, page 31. From the standpoint of the metal and the condition of its surface 3 principal factors influence corrosion: the law of homogeneity, law of concentration limit of solid solutions and law of self-protection. An alloy forming a solid solution is homogeneous, has increased resistance to oxidation and can be readily worked. Additions of other metals to increase chemical resistance should enter into solid solution, and should be present preferably in amounts corresponding to their solid solubilities; below a certain concentration of such additions chemical resistance is not obtained. Self-protection is given by adding a metal nobler than the solid solution, so that an oxide film of sufficient thickness and continuity
4 to prevent progressive corrosion is formed on the surface. Martensitic, ferritic and austenitic steels containing Cr and Ni meet these conditions very well, occasionally with additions of Cu, Mn, Al, etc. Compositions, properties and applications are described. Ha (11b)

Strain Hardening of Bodies Resembling Mild Steel. A Contribution to the Theory of Plasticity (Die Verfestigung von flusseisenähnlichen Körpern. Ein Beitrag zur Plastizitätstheorie) F. K. G. ODQUIST. *Zeitschrift für angewandte Mathematik und Mechanik,* Vol. 13, Oct. 1933, pages 360-363. Mathematical derivations on strain hardening as restricted to materials of the mild steel type. Neglects re-arrangement phenomena and secondary effects as encountered in metals deformed above the recrystallization temperature such as Pb at room temperature
5 or Fe at red heat. The elastic deformations are neglected and the plastic mass is assumed to be incompressible. The derivations are compared with data of Nadai, Hencky, R. Schmidt, Taylor & Quinney and with experimental results of Ludwik & Scheu. The author applies his formulae to (a) cylindrical rods subjected to plastic torsion and (b) thin walled tubes simultaneously subjected to pulling and torsional stress. WH (11b)

On the Production of Alloy Cast Iron Abroad (Über die Erzeugung von legiertem Gusseisen im Ausland) *Technische Blätter der deutschen Bergwerkszeitung,* Vol. 24, Jan. 21, 1934, page 28. Discussion of recent progress in this field, mentioning (1) Ni-Cr cast Fe of Mond Nickel Co., London, containing 2-4% C, .25-2% Si, .25-2% Mn, 2-5% Ni and up to 2% Cr especially used for chilled mold castings; (2) Ni-Cr-Cu cast Fe of International Nickel Co., especially dis-
6 tinguished by high corrosion resistance; (3) heat resisting cast Fe by A. Le Thomas, in which the alloying constituents are not added in the cupola but at the spout as the metal enters the ladle; (4) Nicrosilal, austenitic heat resisting cast Fe with 20-25% Ni, 7% Si, developed by British Institute of Cast Iron Research; (5) investigations of M. Ballay on the effect of Cu on corrosion properties of austenitic cast Fe; (6) investigations of Cournot & Challansonnet on effect of Mo and Ti on properties of cast Fe; (7) special heat treating method of Bullard Co. for increasing tensile strength and hardness of Ni-Cr cast Fe without loss of machineability. GN (11b)

On Wear Resisting Steel (Ueber einen verschleissfesten Stahl) ALAN KISSOCK. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Jan. 21, 1934, pages
7 25-26; Feb. 4, 1934, pages 48-50. After discussing various types of wear and the advantages and disadvantages of Hadfield's Mn steel author considers composition, heat treatment, and properties of a new type of wear resistant steel containing .75-.80% C, .8-1% Mn, .2-.4% Si, 1.40-1.60% Cr, .6-.8% Ni and .3-.4% Mo. Effect of the various alloying constituents on mechanical properties is discussed. Parts subjected to heavy shock are best used in the forged condition. Large forgings of this steel are successfully applied in various types of heavy ore crushing machines and similar equipment. For parts subjected to less severe shock this steel can be used in the hardened and drawn state. Field of application: lining of ball mills, milling balls, tube mills, etc. For resistance to light shock cast Cr-Mo steel need not be drawn. Application field: transportation parts, flotation and
8 mixing machines. Results of practical tests establish the superior wear resistance of Cr-Mo steel as compared to other wear resisting steels. GN (11b)

How Distribution Problems are Dealt with at Bristol. G. C. GUNSTON. *Gas World,* Vol. 98, May 23, 1933, pages 490-493. From a paper presented before the Western Junior Gas Association, April 29, 1933. Tests on cast and spun iron mains showed that the ordinary cast iron main was more elastic than the spun iron. Describes the methods used at Bristol for wrapping the pipes before transit as well as the soap and water test applied to the steel mains at 100 lbs./in.^{2} air pressure before delivery and after laying. MAB (11b)

Pearlitic, Martensitic and Austenitic Cast Iron (Perlitisch, martensietisch en austenietisch gietijzer) M. WAEHLERT & R. HANEL. *De Ingenieur,* Vol. 48,
9 Oct. 13, 1933, pages W193-W198. Improvement in quality of cast Fe by addition of Ni, with and without addition of Cr is discussed. The great variety of possible uses in mechanical and chemical industries is discussed and proper heat-treatment for various purposes described. A table shows the resistance of "Niresist" cast iron to corrosion by acids, alkalis and organic substances as compared with ordinary cast iron and phosphor bronze; and electrical and magnetic properties in comparison with other materials used in electrical industries are also given. 6 references. Ha (11b)

Dependence of Gray Iron on Quality of the Mold (Die Abhängigkeit des Graugusses von der Formbeschaffenheit) A. VAETH. *Die Giesserei,* Vol. 21, Jan. 5, 1934, pages 1-3. The influence of water content of molding sand on properties
10 of gray iron was studied. Bending strength, hardness and graphite nucleus number increase with moisture content of the mold; deflection is reduced by and is most sensitive to increases in moisture content. Increased moisture content promotes formation of the phosphide eutectic and makes cast iron more brittle. Castings of less than 10 mm. thickness show variations in strength which are due to a transition zone between the stable and metastable forms of structure. Charts and tables illustrating these points are given. Ha (11b)

EFFECT OF TEMPERATURE ON METALS & ALLOYS (12)

L. JORDAN, SECTION EDITOR

The abstracts in this section are prepared in co-operation with the Joint High Temperature Committee of the A.S.M.E. and the A.S.T.M.

Stresses in Boiler Tubes Subjected to High Rates of Heat Absorption. WM. L. DE BAUFRE. *Transactions American Society of Mechanical Engineers,* Vol. 55, *Fuels & Steam Power Section,* Sept. 15, 1933, pages 73-103. See *Metals & Alloys,* Vol. 4, Nov. 1933, page MA 369. Ha (12)

Thermal Examination of Alloys by the Differential Method in an Atmosphere of Rare Gases (Thermische Untersuchungen von Legierungen nach der Differnzmethode in Edelgasatmosphäre) E. ALBERTI. *Zeitschrift für technische Physik,* Vol. 14, No. 7, 1933, pages 281-283. To determine the equilibrium diagram of Al-Ba it was necessary to provide an atmosphere with which the 2 elements would not react. Argon was selected. The measuring arrangement with an electric furnace up to 1050° C. is described. Ha (12)

Factors Affecting Choice of Working Stresses for High-Temperature Service. P. G. MCVETTY. *Transactions American Society for Mechanical Engineers,* Vol. 55, *Applied Mechanics,* July-Sept. 1933, pages 99-102. Methods for determining safe working stresses for high-temperature service are discussed with the object of arriving at a basis for selecting practical working stresses for safe application of metals and alloys. The value of accelerated creep tests and the permissibility of extrapolation in time-temperature and stress-deformation curves are discussed; tests should be made under conditions which limit extrapolation to a minimum. 17 references. Ha (12)

The Investigation of the Growth of Cast Iron (Die Untersuchung des Wachstums von Gusseisen) R. MITSCHE. *Die Giesserei,* Vol. 20, Aug. 4, 1933, pages 330-331. An arrangement of a tubular furnace in connection with a dilatometer is described. It permits measuring and recording growth of cast iron at different temperatures and in different atmospheres as well as under a vacuum. Ha (12)

Contribution to the Study of Elastic Deformations of Steam-Pipes under thermal Expansion (Contribution à l'Etude des Déformations Elastiques des Tuyauteries à Vapeur sous l'Influence de la Dilatation) H. CARLIER. *Chaleur et Industrie,* Vol. 13, Nov. 1932, pages 617-626. Develops a method for computing elastic deformations of tubes and illustrates the use of a general formula. FR (12)

New Developments in the Construction of Steam Boilers (Neuere Entwicklung des Dampfkesselbaues) E. LUPBERGER. *Stahl und Eisen,* Vol. 53, Oct. 5, 1933, pages 1021-1030; Oct. 12, pages 1052-1063; Oct. 19, pages 1080-1084. An exhaustive report on recent developments in steam boiler construction emphasizing the trends to high operating pressures and temperatures, to larger units and output, and to simpler construction. A number of recent designs are illustrated and their construction and operation described. The treatment of boiler water is also discussed; the need for special steels for boilers is mentioned but this subject is not dealt with in detail. SE (12)

Tensile Strength and Reduction of Area of Cast Steel at 650° to 1450°C. (Zugfestigkeit und Einschnürung von Stahlguss bei 650 bis 1450°) E. PIWOWARSKY, B. BOZIC & E. SÖHNCHEN. *Archiv für das Eisenhüttenwesen,* Vol. 7, Aug. 1933, pages 127-130. The tensile strength and reduction of area of several cast steels (electric, basic and acid open-hearth, and Bessemer steels containing 0.2-0.4% C) were determined in relation to the columnar grain formation and the testing temperature. The tensile strength decreased gradually with rising temperature, except for a slight jump in the α-γ transformation range. The strength was generally greater normal to the direction of the columnar grains. Reduction of area showed a maximum at 1250° C., and was also greater normal to the direction of columnar grains. SEp (12)

Heat-Resisting Cr-Ni-Fe Alloys for Furnace Construction. L. J. STANBERY. *Metals & Alloys,* Vol. 4, No. 9, Sept. 1933, pages 127-135. This installment covers load carrying ability of this type of material at high temperatures. 18 references. WLCp (12)

Factors Affecting Furnace Practice. R. J. SARJANT. *Gas Journal,* Vol. 200, Oct. 12, 1932, pages 156. See *Metals & Alloys,* Vol. 4, Dec. 1933, page MA 401. MAB (12)

The Creep of Metals. A. NADAI. *Transactions American Society of Mechanical Engineers,* Vol. 55, Applied Mechanics, Apr.-June 1933, pages 61-77. See *Metals & Alloys,* Vol. 4, Aug. 1933, page MA 268. Ha (12)

Tensile Testing of Bars and Wires at Low Temperatures (Festigkeitsprüfungen an Stangen und Drähten bei tiefen Temperaturen) F. PESTER. *Korrosion, Supplement to Chemischen Apparatur,* Vol. 8, Mar. 25, 1933, page 11. See *Metals & Alloys,* Vol. 3, Nov. 1932, page MA 334 Ha (12)

An Experimental and Analytical Investigation of Creep in Bending. G. H. MACCULLOUGH. *Transactions American Society of Mechanical Engineers,* Vol. 55, Applied Mechanics, Apr.-June 1933, pages 55-60. See *Metals & Alloys,* Vol. 4, Aug. 1933, page MA 268. Ha (12)

Metals at High Temperature—Test Procedure and Analysis of Test Data. ERNEST L. ROBINSON. *Transactions American Society of Mechanical Engineers,* Vol. 55, Applied Mechanics, July-Sept. 1933, pages 145-150. Tests extended over two years at high temperatures under stresses so small that the resulting distortions are less than 0.1% did not lead to definite conclusions with respect to allowable stress and rate of flow; besides these quantities, total extension, time elapsed and similarity to actual service conditions should be given to make practical application of the results possible. 6 references. Ha (12)

Creep Testing of Metals and the Application of Creep Test Data to Industry. ELBERT S. ROWLAND. *Mineral Industries, Pennsylvania State College,* Vol. 3, Jan. 1934, pages 1-2. General. AHE (12)

The Abnormal Creep during Transformation of Metals and Alloys. KEIJI YAMAGUCHI & KOZO NAKAMURA. *Bulletin Institute of Physical and Chemical Research, Tokyo,* Vol. 12, July 12, 1933, pages 594-608. Test pieces of about 4 mm. diam. were supported on 2 points 5 cm. apart and loaded in the centre. The change of deflection corresponding to a certain definite range of temperature change was observed by a dial gauge or an optical lever. The creep velocity was computed from the inverse rate curve and deflection curve established simultaneously. The creep velocity of metals and alloys during heating and cooling increases abruptly due to structural changes. This phenomenon was studied in Sn and Al bronze, brass, and Al-Zn alloys with reference to eutectoid transformation as well as to secondary precipitation or dissolution of pro-eutectoid constituents. The same phenomenon was also observed during the graphitization of cast iron, the A_1 transformation of eutectoid steel, the A_3 transformation of iron, and to a minor extent, during the beta-brass transformation near 470° C. It was practically absent during the A_2 change of Fe. WH (12)

On the Creep of Large Aluminium Crystals. ATSUMOTO SHIMIZU. *Journal Society of Mechanical Engineers,* Japan, Vol. 36, No. 194, June, 1933, pages 383-389. Creep tests were made on specimens of aluminum sheet consisting of two or a few large crystals. On continued loading two kinds of deformation were distinguished; the one occurs suddenly and the other as a function of time. The deformation proceeds with the increase of slip lines and the discontinuous change of the direction of the crystals. The progress of the slip deformation depends on the temperature of loading and its intensity. HK (12)

The Effect on Various Steels of Hydrogen at High Pressures and Temperatures. N. P. INGLIS & W. ANDREWS. *Engineering*, Vol. 136, Dec. 1, 1933, pages 613-614. A study was made of the action of hydrogen on various steels for a period of more than five years, at pressures from 200 to 250 atm., and at temperatures between 150° and 500° C. The method of testing consisted of passing pure hydrogen at the required pressure through tubes of the steel to be tested, the tubes in turn being heated in an electric furnace or a steam jacket. The tests were continuous with control of pressure to plus or minus 5 atm. and of temperature to plus or minus 5°C. Seven steels were tested, viz: Two samples of mild steel, a Ni-Cr-Mo, a Cr-V, a 3% Cr, a Cr-Si, and a 6% Cr. Details of tests, such as examination at the end of every 200 hr. period, metallographic appearance of the resulting sample, etc., are discussed in the paper. Mild steel was readily attacked, the deterioration proceeding in two stages: First, an absorption stage with no visible structural effect but lowered physical properties. In the second stage, decarburization and fissuring occur. The foregoing remarks apply to coarse-grained mild steel tubes tested at 250 to 270° C. From 200 to 220° C., the action of the hydrogen was unimportant, even after periods as long as 17,600 hr. At temperatures of 150 to 170° C., no detectable changes occurred. A fine-grained mild steel withstood appreciable attack at 250° C. and 250 atm. for 8,000 hr. The Ni-Cr-Mo steel was unaltered after 8,000 hrs. at 300° to 320° C. and 250 atm. However, some welding so disturbed the structure of the metal that complete perforation took place from hydrogen attack. The same steel at 250 atm. and 450° C., after 13,000 hr. showed total decarburization, with bad fissuring. The Cr-V steel at 450° C. showed total decarburization, with bad fissuring. This steel was somewhat worse than the Ni-Cr-Mo steel, presumably due to the higher carbon content of the former. The 3% chromium steel after 13,000 hr. (temperature not stated) was decarburized to a depth of only 1/12", and partially decarburized and fissured to a depth of 1/6". Beyond the 1/6" the material was unattacked. This steel is, therefore, very much superior to the Ni-Cr-Mo or the Cr-V steel. The Cr-Si steel (temperature and pressure not given), with 0.58% C, 8.36% Cr and 2.50% Si, was unaffected after 13,000 hr. Because of the obvious beneficial effect of Cr, a steel containing 6.35% Cr was tested at even more severe conditions; namely, 200 atm. and 500° C. After 4,500 hr., no sign of decarburization or disintegration was detectable. No fissuring was discovered, even after a drastic test to determine its presence. Samples of the tube were bent flat without signs of cracking. The samples analyzed for hydrogen, showed no absorption. An 18-8 steel was also tested at 250 atm. and 450° C. After 7,900 hr., a heavy carbide precipitation had occurred at the grain boundaries, with consequent embrittlement of the steel as shown by the flattening test. The authors make much of the fact that carbide precipitation took place at a temperature well below that at which it ordinarily occurs. This they ascribe to the possibility of the lowering of the limits of carbide migration by the presence of hydrogen or due, on the other hand, to the effect of heating under stress.
C. E. MacQuigg (12)

The Effect of Time and Temperature on the Embrittling of Steels. A. M. McKAY & R. N. ARNOLD. *Engineering*, Vol. 136, Dec. 8, 1933, page 623; Dec. 15, 1933, page 647. Previous work of Bailey is reviewed, in which it was found that many of the more useful Ni-Cr steels were susceptible to embrittlement unless they contained more than 0.7% Mo, in which case they were free from this defect. Bailey's tests ran to 250 hr., which he considered to be adequate. The present authors disagreed, and ran tests to 1,000 hr. Ten steels were tested, all but two of which contained significant quantities of Ni and Cr; some contained Mo, V, W, and Cu as well. Curves relating embrittlement to time of soaking at various temperatures show the behavior of the individual steels. In addition to the work on the alloy steels, some mild steels were quenched from 650° C., drawn at 450° C., and then aged for periods varying from 12 to 4,000 hr. at 300, 500, and 600° C. respectively. The steel with 22% Cr, 12% Ni, 0.10% C and 2.86% W gave a very good account of itself, but did show embrittlement up to about 50% of the Izod value—that is, a drop from 38 ft.-lb. to 20 ft.-lb. after six months at 500° C. Two plain Cr-Ni, relatively low carbon steels, and one containing Cr, Ni and Mo were free from embrittlement after 2,000 hr. at temperatures up to 500° C. The authors infer that, in general, stress is not a contributing factor, and conclude that the combination of approximately 3% Ni and 1% Cr gives rise to serious embrittlement, and the addition of 0.43 or 1.44% Mo does not reduce the embrittlement, although Mo in other steels retards the rate of embrittlement. Mo, however, will not prevent embrittlement, as after a given time its initial effect is entirely counteracted. Embrittlement was shown to result in the mild steel from quenching below the lower critical point with subsequent aging. During aging, the hardness increased approximately 25%, but the tensile strength was only slightly changed. No structural change could be noted, hence the embrittling effect was submicroscopic. Some X-ray tests were noted, but the effects were not very clear-cut and were thought to be due to increase in the grain size.
C. E. MacQuigg (12)

High-Sensitivity Creep-Testing Equipment at National Physical Laboratory. H. J. TAPSELL & L. E. PROSSER. *Engineering*, Vol. 137, Feb. 23, 1934, pages 212-215. The authors describe a new testing machine, lately installed, capable of measuring the very small amounts of creep which may be expected to occur in metals under normal working conditions. The reason for this additional sensitivity has been to study creep at low stresses. This machine will supplement the National Physical Laboratory equipment measuring strains of about 2.5 by 10^{-5} inch per inch. Sketches and photographs accompany the article, illustrating the apparatus and typical creep test curves. The apparatus proper consists of steel framework deeply imbedded in concrete, with four independent, vertical double levers for applying loads. The test piece is usually .564" in diameter and 5" gage length, screwed into heat-resisting steel adapters about 19" long. Wire wound furnaces capable of developing a temperature of 800°C. are wound on a silica tube 18" long and 3¼" in diameter. The temperature is measured by means of Nichrome-constantan thermocouples bound to the surface of the test piece, and connected to a potentiometer reading to one microvolt. A mirror type of extensometer is used and in order to guard against errors due to the possibility of non-axial loading, each extensometer is duplicated on either side of the test piece. Individual resistance-thermometer control is used for each furnace, the control resistance consisting of a platinum resistance, wound on a silica tube placed between the furnace tube and test piece. The operation of the circuit is as follows: Two resistances govern the furnace current. The first is adjusted to supply somewhat less current than the required value for the furnace. The second, shorted periodically by a contactor operated by the temperature of the platinum coil within the furnace, varies the furnace current intermittently by 20%. The thermal inertia of the furnace is thus sufficient to keep the test piece at a steady temperature. The sensitivity obtainable with these machines is shown by the results of two typical creep tests. In a test on Ni-Cr-Mo steel at 450°C., under a stress of 10 tons/in.^{2}, after 1,500 hr. the creep rate had fallen to an easily measurable value of 2 x 10^{-7} inch per inch per hr. The load was then removed and the material allowed to recover, the creep recovery rate falling to 1.7 x 10^{-7} inch per inch per hr. after a further 1,000 hr. The temperature was measured daily, and the largest variation observed was within ±⅛°C. of the mean value. The nature of the reading obtainable at a lower creep rate is shown by a portion of a creep test on a stainless steel at 450°C., and 4 tons/in.^{2}, plotted on a logarithmic time base. The creep rate of 3.7 x 10^{-8} inch per inch per hr. after 1,200 hr. creep may be measured fairly accurately, while still lower creep rates corresponding with a smaller slope of the creep-strain-log duration curve can be determined from tests of about the same duration.
C. E. MacQuigg (12)

Attempts to Find a Definition of Creep Stability (Ueber Versuche zur Begriffsfestsetzung der Dauerstandfestigkeit) H. JURETZEK & F. SAUERWALD. *Zeitschrift für Physik*, Vol. 83, June 28, 1933, pages 483-491. Creep stability or creep strength can be defined by that load which can be supported permanently after flow in the material has come to rest. The exact measurement requires a long time and is difficult. Recent investigations have indicated that a relation exists between the increase of rate of elongation with the load and the limiting values of creep strength; this may offer a basis for an exact definition of creep strength which, at present, is still lacking. Experiments with different types of steel are described.
Ha (12)

Fatigue and Impact Strength of Steel at Low Temperatures (Bidrag till kännedomen om stals hallfasthet mot utmattning och slag vid lag temperatur) OTTO FORSMAN. *Jernkontorets Annaler*, Vol. 117, Nov. 1933, pages 519-530. Tests were made on carbon steel, Cr-Ni steel and ordinary rail steel all of Swedish manufacture. Tensile tests were at 20°, fatigue tests under pulsating load at 20° and —18°, and notched bar impact tests between —60° and +40°. A slight rise in fatigue limit was noted with falling temperature. The impact figure falls rapidly with falling temperature in a critical region between —20° and +20°, but may be markedly changed by heat treatment. The change from high to low impact figures is gradual for hard steels, but rapid for mild steels used for structural purposes.
HCD (12)

Temperature Coefficient of Aluminum (Sul coefficiente di temperatura dell' alluminio) O. SCARPA. *Alluminio*, Vol. 2, Nov.-Dec. 1933, pages 317-322. The value of the temperature coefficient of electrical resistance of Al at 20°C.—namely, 0.00407— assigned at the last meeting of the International Electrotechnical Committee (Stockholm—July 1930)—should have only 4 digits, as the precision of the data does not warrant carrying the 5th. The summarized data of several investigators show that for Al, annealed at 250°, the best value of the average temperature coefficient between 0°-100°, referred to that at 0°, is 0.0044; and referred to 20°, the best value is 0.0040.
AWC (12)

Steels for Use at High Temperatures. *Engineer*, Vol. 156, Dec. 1, 1933, page 554. Gives an outline of the scope of the research carried out at the National Physical Laboratory under the direction and control of the Joint Committee representing the British Electrical and Allied Industries Research Association and the National Federation of Iron and Steel Manufacturers. See also editorial on page 549 and discussion on pages 542-543 of the Dec. 1, 1933 issue of *Engineer*.
LFM (12)

Pipe Lines for High Pressures and Elevated Temperatures (Rohrleitungen für hohe Drücke und Temperaturen) C. KAUB. *Die Wärme*, Vol. 56, Dec. 16, 1933, pages 813-815. Recommends extending the utilization of seamless steel tubes admitted for 25 atm. maximum pressure to superheated steam and accordingly to change the German standards DIN 1629. Various possibilities of welding flanges, sleeve joints, and connecting branches are shown in 15 illustrations and discussed with reference to the pressure range. Welded joints reinforced by Höhn straps and zigzag seams are considered and a wider adoption of welding methods advocated.
EF (12)

Superconductivity of Metals Observed at Low Temperatures. J. C. McLENNAN. *Electrical Review*, Vol. 112, Mar. 10, 1933, pages 344-345. See "Electric Supra-Conduction in Metals," *Metals & Alloys*, Vol. 5, Feb. 1934, page MA 37.
MS (12)

Certain Irregularities in Stress-Strain Curves of Steel Treated at High Temperatures (Sur Certaines Particularités des Courbes de Traction des Aciers à Chaud) J. GALIBOURG. *Art-et-Metiers*, Vol. 85, Jan. 1933, pages 36-37. Abstract from a lecture at the Academie des Sciences. See *Metals & Alloys*, Vol. 4, Nov. 1933, page MA 369.
FR (12)

Modern Heat Regenerators (Neuzeitliche Warmerückgewinnungsanlagen) A. JAESCHKE. *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 24, Feb. 25, 1934, pages 104-107. Paper also discusses properties of heat resisting steels as used in steel regenerators that are discussed at length.
GN (12)

Heat Transfer in Jacketed Vessels. BASIL HEASTIE. *Industrial Chemist*, Vol. 9, Nov. 1933, pages 371-372, 380. Methods of calculating heat conductivity of steel, glass and rubber lined steel, and nickel-clad steel are given.
RAW (12)

The Strength and Behavior of Steels at High Temperatures. W. H. HATFIELD. *Proceedings Institution of Mechanical Engineers*, Vol. 123, Dec. 1932, pages 773-791. A rather general article concerned primarily with creep, yield point, and the time yield at temperatures up to 1000°C. An extensive table gives data on a variety of plain carbon and alloy steels (mild C. higher C. 3% Ni-low C, C-Mo, Ni-Cr-Mo, Cr-Al, Si-Cr, stainless, 18% Cr-8% Ni, 18% Cr-8% Ni-W-Ti, Ni-Cr-W, C-Cr-Mo, W-Cr-V) and some high speed steels. Other tables show effect of high temperatures on the physical properties of normalized and annealed steel bars and forgings. Previous work has shown that the original Cr and Cr-Ni rust- and acid-resisting steels could be greatly improved both in strength and in increased resistance to oxidation at high temperatures by the addition of other elements. High percentages of Cr, or of Ni alone will not improve the strength of steels at high temperatures. If, however, Si, Ti, and W are added to alloys containing both Ni and Cr, then steels are obtained which have great strength and high resistance to scaling.
RHP (12)

Correlation of Hot-hardness and Cutting Efficiency of Tool Steels. O. E. HARDER & H. A. GROVE. *Metal Stampings*, Vol. 6, May 1933, page 148. See "Hot-hardness of High-speed Steels and Related Alloys," *Metals & Alloys*, Vol. 4, Dec. 1933, page MA 400.
MS (12)

Comparative Studies on Creep of Metals Using a Modified Rohn Test. C. R. AUSTIN & J. R. GIER. *Metals Technology, American Institute Mining & Metallurgical Engineers, Technical Publication* No. 544, Feb. 1934, 21 pages. Using the modified Rohn apparatus previously described tests were made on Fe, Ni, Co, Ag, a steel containing 18% Cr and 8% Ni, and a steel containing 0.45% C, 3.25% Si and 8.5% Cr. Each material was tested with several loads. The influence of method of loading on final results was studied. It was concluded that the test serves as a ready means for determining the comparative creep characteristics of metals at elevated temperatures.
JLG (12)

The Interference Method of Measuring Thermal Expansion. GEORGE E. MERRITT. *Bureau of Standards Journal of Research*, Vol. 10, Jan. 1933, pages 59-75. Report is intended as a manual for the use of those who wish to measure thermal expansions by the interferometric method. As such, a more complete description of the apparatus and methods developed is included than would be in order in a paper dealing primarily with the results of a particular set of measurements. The apparatus, method of making specimens, forms of taking data, and computation of data, is the subject of a careful exposition. An appendix contains tables and special calculations.
WAT (12)

Requirements in Materials for Valves and Fittings for High Temperature High Pressure Field J. J. KANTER & H. W. MAACK. *Oil & Gas Journal*, Vol. 31, Oct. 27, 1932, pages 13-16. Before Mid Continent Section American Society of Mechanical Engineers. Data are presented on the properties of the non-ferrous alloys, cast irons, steel castings and corrosion-resistant steels from the standpoint of valve material for use at high temperature.
VVK (12)

CORROSION & WEAR (13)

V. V. KENDALL, SECTION EDITOR

An Investigation of Certain Corrosion-Resistant Steels. J. L. MILLER. *Carnegie Scholarship Memoirs, Iron & Steel Institute,* Vol. 22, 1932, pages 111-151. Part I. Some alloys for use in contact with H_2SO_4. Resistance of 28 commercial alloys and 84 alloys prepared by author to determine their resistance to boiling 10% H_2SO_4 are presented. Previous workers have indicated that Si, Cu, Ni, Mo and Co are more or less resistant at various percentages, Mn not at all, and Cr at too high a percentage. Pure metals were tested and showed Si, Mo, Cu, and Ni had high resistance. Commercial alloys gave best results where 4 or 5 components formed the alloy and indicated that relatively small amounts of Si, Cu, W, and Mo increased resistance greatly. The first series of the new compositions gave poor results with Mo up to 5%, where resistance increased slightly. Ni decreased corrosion in a straight line from 5 to 30%. Curves for Mo and Ni, alone and in combination, are given. A second series of 49 alloys without Mo, of 5-40% Ni, 3-20% Cu, 3-4% Si, and 5-20% Cr, quenched from 900° C. showed corrosion resistance increased with Cu from 0-12.5%. From 12.5-20% Cu, resistance declined. Ni increases resistance up to 30%, beyond, a slight decrease occurs. Si of 3% is more effective than 3.5 or 4%. Cr is ineffective to 20% where a sudden drop in corrosion occurs. Graphs show the curve for each element. 43 micrographs show structure and prove that Ni helps retain more Cu in solid solution. Cu-bearing alloys would be less resistant in HNO_3. Forging tests showed the 30% Ni, 3% Cu, and 3% Si alloy forged readily, but increasing Cu was injurious in this respect. From a cost standpoint, this alloy has best possibilities. With 10% Cu in cast form, corrosion resistance possibilities are promising. Part II. Intercrystalline Corrosion in Cr-Ni Austenitic Steels. Previous attempts to prevent intergranular corrosion are discussed. Various heat treatments for different periods in their effects on corrosion and relative magnetism are tabulated. C solubility limit was determined as 0.02%. In excess of this amount, precipitation occurs and migrates to the grain boundaries. With higher C a larger amount precipitates and coalescence is more rapid. The higher the previous quenching temperature, the slower the rate of precipitation. 1700° F. is the minimum possible quenching temperature for carbide precipitation in an 18-8 0.08% C alloy. This minimum increases with C to 1900° F. Maximum C agglomeration occurs at 1500° F. Maximum precipitation and corrosion susceptibility occurs at 1200° F. Magnetic tests indicate amount of α-Fe increases at 1200° F. with time. Long heating at higher temperature decreases the amount. The γ-phase is unstable below and stable above 1200° F. C precipitation causes local unbalancing of alloying elements above 1200° F. resulting in α-Fe formation. Migration occurs with time and austenite forms again. 2 weeks heating at 1500° F. eliminates corrosion, but previous cold work lowers this time greatly without loss of physical properties. A new theory of carbide precipitation mechanism presented postulates the migration of C with formation of Fe-rich carbide at the grain boundaries. This carbide slowly transforms to Cr carbide by diffusion. When the Cr content of the compound becomes high enough, resistance to corrosion is established. An addendum gives results of experiments to reduce heating time for intergranular corrosion resistance. Small grain size specimens heated 2-3 days or over showed good resistance. 16 references. WLC (13)

Corrosion (Korrosion) PRZYGODE. *Verkehrstechnik,* Vol. 50, Jan. 20, 1933, page 37. Paper by Wolf on oil and cellulose lacquers before 4 leading German technical societies is fully dealt with. WH (13)

Corrosion in Gearing. J. R. KAMMEL. *The Commonwealth Engineer,* Vol. 21, Oct. 2, 1933, pages 75-76. Corrosion in gearing is due to electrolytic action set up by pressure between the metal surfaces in contact surrounded by an electrolyte such as is commonly present in the form of moist vapors in the air or in the lubricant. Severity of corrosion increases with the power transmitted and with the speed of the gears. Various experiments have been undertaken to find a lubricant that would be anodic towards steel and thus inhibit its ionization. Excellent results were secured with lubricants containing a considerable amount of Zn oxide (about 50%). After continuous running the metal surfaces were found to be plated with a metallic Zn layer of from 1 — 4 x 10^{-4}mm. thickness. The adherent Zn deposit formed by electrolytic action entirely eliminated the corrosion attack. WH (13)

The Varying Behavior of Protective Zinc Plates in the Boilers of the German Railway Steam Ferries (Über das wechselnde Verhalten von Zinkschutzplatten in den Kesseln von Reichsbahn-Fährschiffen) R. KÜHNEL. *Paper Third Corrosion Congress Verein deutscher Ingenieure, Verein deutscher Eisenhüttenleute, Deutsche Gesellschaft für Metallkunde and Verein deutscher Chemiker,* Nov. 14, 1933, Berlin. Mimeographed report, pages 4-5. Zinc plates suspended for corrosion protection in the boilers of steam ferries varied in behavior. Frequently they were destroyed within a short time, sometimes they remained intact for a long time. Plates of 7 different Zn brands were suspended at different locations in the boilers after chemical composition and mechanical properties had been determined. The hardest plate showed the highest corrosion stability, the softest the lowest. Therefore harder Zn plates are superior to softer for this purpose. GNp (13)

Metallic Protective Coatings on Iron (Metallische Schutzüberzüge auf Eisen) HEINZ BABLIK. *Oberflächentechnik,* Vol. 10, July 4, 1933, pages 151-154. Low C steel is protected and its appearance improved by metallic coatings which are deposited by (1) immersion, (2) cementation, (3) galvanic or electrolytic methods and (4) by spraying. The table shows the most used metals for this purpose and the methods by which they are deposited:

Metal	Melting Point° C.	Method: Immersion	Galvanizing	Cementing	Spraying
Tin	232	Hot-tinning	Electrolytic tinning	....	....
Lead	327	Hot-leading	Electrolytic leading	....	....
Zinc	419	Hot-galvan.	Electrolytic galvan.	Sherardizing	Spray zincing
Aluminum	659	....	....	Calorizing	Alumetizing
Cadmium	321	....	Cd plating	....	....
Copper	1083	....	Cu plating	....	Spray coppering
Nickel	1452	....	Ni plating	....	Spray nickeling
Chromium	1565	....	Cr plating	....	....

Iron, melting point about 1530° C.

The immersion method, in which the coating metal is in the molten state and the metal to be coated heated up on its surface to the same temperature, offers the best opportunity for an exchange of crystals as the atoms are very mobile; hot-galvanizing, for instance, forms the intercrystalline compound $FeZn_7$. The pure metallic protective coat of the immersion method is, therefore, connected to the Fe base by an alloy layer. The cementation method causes only a diffusion of the protecting metal into the Fe surface where an alloy may be formed, but the pure layer of protecting metal is missing. Electrolytic methods have no alloying effects, the coating metal is simply in very close metallic contact with the Fe base. Spraying is mainly a mechanical adherence of the sprayed-on material to the surface of Fe made rough for better adherence; this method is used more for decorative than protective effects. The greatest importance is freedom of pores for which a certain thickness of the coating is required; the latter depends upon the nature of the protecting metal and can change from 0.00025 mm. to several mm.; a table showing the thicknesses obtained with the different methods is given. Hap (13)

Investigations of Wear of Different Kinds of Cast Iron for Automobile Cylinders by Wear Testing Machines and Automobile motors (Verschleissuntersuchungen verschiedener Automobilzylindergusseisen mit Verschleissmaschinen und Kraftfahrzeugmotoren) A. Wallichs & Joh. Gregor. *Die Giesserei,* Vol. 20, Nov. 24, 1933, pages 517-523; Dec. 8, 1933, pages 548-555. Alloyed and unalloyed cast irons for cylinders of automobile motors were tested for wear by a method for which the samples to be tested were made from plates cast in the thickness of the cylinders. A slight decrease of wear was found with increasing hardness and increasing difference of hardness of the gliding metals. A relation could be found between wear and wall thickness; castings of large sections show less wear than thin sections. This is due to the structure which, in the thinner sections, has graphite inclusions of smaller size and greater number and thus contributes to wear. Very wear-resistant samples of more than 3% Ni + Cr and 30 mm. wall thickness had a pearlitic-sorbitic structure and with 6.3% Ni + Cr a fine martensitic structure. High pouring temperatures and dry molds contribute to wear-resistant castings. Alloying additions of more than 3% Ni + Cr have, on the average, 25% less wear than unalloyed iron, which is due mainly to the increase of hardness by Ni and Cr. No advantage could be found in centrifugal casting. If good wearing resistance is to be combined with good machinability (chippability) for which latter low hardness is desirable, unalloyed castings poured at high temperatures with little graphite is recommended. Tests are described in detail and structure shown in micrographs. Ha (13)

Effect of Heat Treatment on the Corrosion Stability of Condenser Tubes (Einfluss der Glühbehandlung auf die Korrosionsbeständigkeit von Kondensatorrohren) E. Schumann. *Paper Third Corrosion Congress Verein deutscher Ingenieure, Verein deutscher Eisenhüttenleute, Deutsche Gesellschaft für Metallkunde and Verein deutscher Chemiker,* Nov. 14, 1933, Berlin. Mimeographed report, page 5. 15 groups of condenser tubes of same chemical composition (70% Cu, 29% Zn, 1% Sn) but differing in mechanical properties, grain size and surface condition due to different heat treatment (increasing annealing temperature and time, different annealing atmosphere) were tested. There was developed for laboratory tests a simple but sensitive apparatus that permitted the study at constant temperature of the electrochemical behavior of the surface at different places. With other but also pretreated samples practical service tests were made. In these tests one tube of each of the 15 groups was examined after ½ year service. The tubes were examined microscopically and results compared with electrochemical measurements. Laboratory and service tests are in agreement. Thus it was possible to determine the effect of structure, surface condition (continuous or discontinuous scale skin with various annealing types and temperatures) on the corrosion properties of condenser tubes. GN (13)

Corrosion by Cavitation (Korrosion bei Kavitation) H. Schroeter. *Zeitschrift verein deutscher Ingenieure,* Vol. 77, Aug. 12, 1933, pages 865-869. Describes tests made to study the cavitation of easily corroding materials at different flow conditions of the impinging medium and to determine the velocity of progress of corrosion. The influence of roughness of surface is very great. Definite conclusions are not yet arrived at; further studies are being undertaken. Ha (13)

Corrosion by Electrolysis in Heating Elements of Cooking Plates Disconnected on One Pole only (Korrosion durch Elektrolyse an Heizspiralen von einpolig abgeschalteten Kochplatten) W. Schmidt. *AEG-Mitteilungen,* July 1933, pages 139-142. Heating elements imbedded in ceramic insulating masses and disconnected with one pole only are subject to corrosion when the plates, when not used, are under the influence of a positive d.c. current against the housing. This has, however, no influence on the life of the elements. A.c. has no corroding influence on the heating elements. Ha (13)

Rusting of Iron in Excess of Oxygen (Ueber das Rosten des Eisens bei Sauerstoffüberschuss) G. Schikorr. *Zeitschrift für Elektrochemie,* Vol. 39, July 1933, pages 409-414. The rusting of Fe which is immersed in quiet water of room temperature depends upon the diffusion of O; impurities in the Fe and neutral electrolytes in the water have no importance. On the other hand, if rusting takes place in the atmosphere or in moving water saturated with air at 3° C. O exerts passivating properties which inhibit rusting; impurities in the iron and electrolytes, especially Cl-ions in the water counteract the passivity and increase corrosion. The results of the tests are given in full. 15 references. Ha (13)

Rust Proofing Refrigerator Parts. *Iron Age,* Vol. 131, Jan. 26, 1933, page 168. Bonderizing of all metal surfaces not only rust-proofs the metal, but in case of parts which are to be enameled, leaves a slightly absorbent surface, which gives a more permanent bond between enamel and metal. Claims that this has eliminated all peeling or cracking. The method described is used by the Maine Mfg. Co., Nashua, N. H. VSP (13)

Comparison of Constancy of Gold- and Chromium-Plated Analytical Weights. Harvey V. Moyer & Paul K. Winter. *Industrial & Engineering Chemistry,* Vol. 26, Feb. 1934, page 238. Results show that Cr is superior to light Au-plating for analytical weights. It is thought that the superiority of Cr is due to its greater resistance to scratching and abrasion, and that heavier plating with Au would probably not excel ordinary Cr-plating. MEH (13)

The Study of Protective Films against Corrosion formed on the Surface of Light Alloys. Hikozo Endo & Masayoshi Tagaya. *Kinzoku no Kenkyu,* Vol. 10, May 1933, pages 179-199; June 1933, pages 227-242. In Japanese. Specimens of aluminium and magnesium were dipped in various salt solutions for a definite time and the metal surfaces were then examined for the formation of insoluble protective salt coatings. The following salt solutions were found to be advantageous to the purpose: (1) 2% $KMnO_4$ + 2% H_2SO_4 + 2% MnO_2, and (2) 1% CaO + 1% $CaSO_4$ (or ZnO) + 0 ~ 1% $KMnO_4$ for aluminium and its alloys. The metals were immersed in boiled solutions for 30 to 40 minutes. (3) 10% Na_2HPO_4 (or K_2HPO_4) + 3% NaOH (or 4% Na_2CO_3) saturated with $Mg_3(PO_4)_2$, (4) 0 ~ 10% Na_2HPO_4 + 0.5 ~ 5% NaOH + 0 ~ 3% $Mg_3(PO_4)_2$ + 1.0 ~ 3.0% $K_2Cr_2O_7$ + 0.5 ~ 3.0% $Al_2(SO_4)_3$ (or KAl $(SO)_2 \cdot 12\ H_2O$), (5) 1% H_2SeO_3 + 1% Na_2CO_3 etc. for magnesium and its alloys. The metals were immersed for a few hours. Further it was found that the most promising method of preparation of protective coatings consisted in the above chemical treatment of the metal surface followed by a coating of lanolin, bakelite varnish or special rubber. The protective films were merely a few thousandths of a millimeter thick, and the dimensions of the metals and alloys was not affected appreciably. The films were capable of resisting a severe bending or other mechanical treatment and formed a satisfactory base for certain types of paint, lacquers, etc. KT (13)

On the Single Potential of Aluminum. H. Endo & S. Kanazawa. *Kinzoku no Kenkyu,* Vol. 10, Nov. 1933, pages 471-487 (In Japanese); *Science Report, Tohoku University,* Series 1, Vol. 22, Aug. 1933, pages 537-552. (In English.) The single electrode potential of Al in 1 n. KCl solution has been carefully determined, the effect of the elements usually contained in aluminium as impurities as well as that of gases existing in the electrolytic solution being also observed. The electrolytic solution used was prepared from a pure potassium chloride and conductivity water made free from oxygen, and the observations excepting those for the effect of various gases were all carried out under an atmosphere of hydrogen. The following is the summary of the results of the present investigation: Different samples of aluminium used gave different results owing to the difference in the content of impurities, especially iron. Iron added to aluminium lowered the electrode potential (absolute value), but silicon did not. Hence, as the most probable value for pure aluminium, the potential −1.29 volts has been obtained by extrapolating the potential-iron content curve to the point zero per cent iron. Among the gases passed over the electrolyte, hydrogen, nitrogen and carbon dioxide caused no appreciable change in the result, but oxygen seriously lowered the electrode potential. The lowering of the potential due to O is ascribed to the formation of an oxide film on the electrode surface. KT (13)

Wear of Gears (Abnutzung von Zahnrädern) M. Fink & U. Hofmann. *Zeitschrift Verein deutscher Ingenieure,* Vol. 77, Sept. 9, 1933, pages 978-979. Wear of metallic materials is, in general, due to (1) mechanical tearing away of metallic particles, (2) cold-deformation of the material, and (3) oxidation by friction. The first two are familiar; the last has been recognized only recently, and occurs when the particles under deforming forces of plastic deformation simultaneously come in contact with O. The places of deformation are chemically active and immediately bind the O of the air thus giving occasion for oxidation. This frictional oxidation occurs even under oil. A sure means for preventing friction oxidation has not yet been found, but it seems that a suspension of colloidal graphite in oil improves lubrication by its greater adhesion to the surfaces of the material forming a 2-dimensional surface alloy and protecting the material from access of O. Ha (13)

Wearing Properties of Cast Iron (Die Verschleisseigenschaften des Gusseisens) P. A. Heller. *Die Giesserei,* Vol. 20, Sept. 8, 1933, pages 392-400. Wear of a material is independent of its composition and physical properties and depends only upon exterior, mechanical influences. In general, wear is proportional to the time of use and has apparently a square relation to the gliding velocity and the pressure between gliding parts. The surface condition of cast iron has a great influence, the more so, the less ferrite the casting contains. Chemical composition has an influence only in as far as it affects the structure. Ferritic cast irons cannot be considered as resistant against wear; pearlite improves the latter. Finely distributed graphite is less favorable for the wearing properties than coarsely segregated graphite. Although graphite can exert a lubricating effect under certain conditions this property is reduced or even prevented when the metallic basic structure is too greatly interrupted. P has been observed to be both favorable and detrimental to wear, exterior conditions seem to determine the effect. Influences of alloying additions to cast iron have not yet been fully elucidated; Ni seems to improve the resistance in automobile cylinder stresses considerably. The relation between hardness and wear is not definite; the variation in hardness between the parts in contact is probably the determining factor. 11 references. Ha (13)

Weld Decay. E. C. Rollason. *Welder,* Vol. 5, Oct. 1933, pages 14-18. Weld decay or intercrystalline corrosion of welds in 18-8 austenitic steels is due to precipitation of the dissolved Cr as finely divided Cr carbide at the grain boundaries thus producing a chemical low in Cr content which is readily attacked by corrosive agents should they be present. The liability to decay can be tested by immersing samples of the weld for 72 hrs. in a boiling solution of 111g. copper sulphate, 98 g. H_2SO_4, and H_2O to make 1000 cc. If free from decay the sample can then be bent without effect on the surface, otherwise cracks appear or even decomposition into powder takes place. Specimens heated at 500°C. for less than 45 min. did not decay, an increase of heating time promoted decomposition. At 700°, a few seconds of heating suffice, above 750° longer time is required. In general, experiments showed that cold work intensifies tendency to intergranular attack, and this condition often prevails due to some shaping process. If the whole piece can be heated to 1000-1150° the defect can be repaired, but for very large vessels where this is impossible a material less liable to decay should be used, such as steels with very low C and fine grain size, and with additions of W, Ti, Si and Mo. Ha (13)

"Gold" as Protector against Corrosion ("Gold" als Korrosionsschutz) P. Steen & O. P. van Steewen. *Werkstoffe und Korrosion,* Vol. 8, Oct. 25, 1933, pages 37-39. Experiments indicate that Au-plating can be recommended for all objects which are not subject to too great mechanical stresses. It is highly resistant against oxidation, acids and alkalis, possesses an expansion coefficient which prevents stretching and wrinkling of the deposit and does, therefore, not crack. On account of its fine crystailinity the coating is very dense and adheres extremely well without spalling. It has a very low potential against Fe which means that local elements have much less effect than a Pt deposit. It is best to use Au on an intermediary layer of Ni for steel; for other metals, one or more intermediary layers under Au should be applied in order to obtain as low as possible a tension between the single layers. Tables of tension, expansion coefficients and electrochemical equivalents for different metals are given. Ha (13)

Resistance of Nitrided Steel under Abrasion Wear (La Resistenza dell' Acciaio Nitrurato al Logoramento per Abrasione) A. Quagliotto. *L'Industria Meccanica,* Vol. 15, Oct. 1933, pages 788-792. Experiments were made with pinpoints of a needle valve of a water turbine to study the influence of the abrasive action of water jet containing the usual impurities, sand, etc. The good behavior of nitrided steel which has been found to behave well under gliding friction also, is indicated in the following comparison:

type of material of valve point	duration of service
Nickel bronze	1½ months
Soft steel	2 months
Manganese steel	2½ months
Forged hard steel	3 months
Forged tungsten steel	12 months
Nitrided steel	18 months

Several examples corroborate these results. Ha (13)

New Tests with Duralplat (Neuere Versuche mit Duralplat) K. L. Meissner. *Paper Third Corrosion Congress Verein deutscher Ingenieure, Verein deutscher Eisenhüttenleute, Deutsche Gesellschaft für Metallkunde und Verein deutscher Chemiker,* Nov. 14, 1933, Berlin. Mimeographed report pages 6-7. Author first surveys development of Al alloys of high strength and corrosion stability: (1) duplex alloys with a hardenable core, (2) non-hardenable alloys with higher Mg content, as for instance, Magnalium, Hydronalium, K-S seawater alloy, Duranalium. Materials used for surfacing are considered, Al of highest purity, duralumin with or without Cu content as used in making Duralplat of various brands. Results of corrosion tests carried on in the North Sea for several years are given and discussed. Three different brands of Duralplat were tested: (1) common Duralplat with a 5% surface layer (2) Duralplate with 10% surface layer but in thinner sections than (1), (3) Duralplat with Cu bearing surface layer. Weight loss, behavior of yield point, tensile strength and elongation are determined in relation to corrosion time. The difference in corrosion behavior as compared with non-duplex alloys are pointed out, in particular the absolutely uniform surface corrosion while tensile properties of surface layer are unimpaired. Due to the uniform attack in this case determination of weight loss is a proper yardstick for the progress of corrosion. Results on Duraplat are compared with those obtained on an alloy of the Magnalium type. Duralplat proved superior. Author finally points out that abbreviated laboratory tests do not permit direct conclusions as regards behavior in sea water. GN (13)

Method for Continuously Measuring the Small amount of Corrosion Associated with Gas Evolution (Essais d'une méthode de mesure continue de faible corrosions accompagnées de dégagement gazeux) A. Portevin, E. Pretet & L. Guitton. *Revue de Métallurgie,* Vol. 30, Aug. 1933, pages 362-365. Suspending test specimen and a receptacle to catch hydrogen evolved on the same thread, attached to the beam of a balance, in corroding solution increased the sensibility of weight loss determination several hundred times. Method is not as accurate as direct weighing of the corroded specimen. H_2 escapes and is difficult to control. JDG (13)

Disintegration of Iron Carbide by Catalysis (Der Zerfall des Eisenkarbids durch Katalyse) Franz Roll. *Die Giesserei,* Vol. 20, June 9, 1933, pages 233-235. **Decomposition of Cementite by Catalytic Action.** *Foundry Trade Journal,* Vol. 49, Aug. 31, 1933, page 119. Various views on the reasons for the disintegration of carbide in cast iron are discussed and a few observations described. Composition and temperature were generally held responsible for the disintegration of Fe_3C but it could be stated that the rate of disintegration is accelerated by CO and CO_2. OWE + Ha (13)

Progress Report on Protective Value of Electroplated Metal Coatings on Steel. Joint Inspection Committee, American Electroplaters' Society, A. S. T. M. and Bureau of Standards, W. BLUM, Chairman. Mimeographed report, Mar. 15, 1933, 5 pages. Tentative conclusions on 1 year's exposure test of Ni and Cr plated steel samples exposed at Key West, Sandy Hook and Pittsburgh (rapid failure), New York (intermediate), Washington, D. C. and State College, Pa. (slow), with monthly examination. With Ni or Ni over Cu and Ni, a thickness of 0.001" of coating or more is required to give good protection. Pure Ni had as good protective value as a composite coating with a layer of Cu. Thin Cr plating over Ni alone was worse than having no Cr present. With an under-coat of Cu, then one of Ni, or a thicker under-coat of Ni alone, covered with 0.00003" of Cr, the Cr gave added protection. Zn or Cd under the Ni had a tendency toward white stains and blisters. Accelerated tests must be made on material clean enough to show water-break. The ferroxyl tests give results approximately parallel to exposure tests. Salt spray is also being used, and stripping tests investigated. The report is based on inspection to March 1st. Zn and Cd coatings are to be studied next and the program includes coatings on brass, Al, Zn and die castings. HWGp (13)

Surface Protection by Chemical Processes (Oberflächenschutz durch chemische Verfahren) GEO. BUETTNER. *Oberflächentechnik,* Vol. 10, Feb. 21, 1933, pages 40-41. The chemical formation of a protective layer on base metals to protect them from corrosion by atmospheric influences is described. Al forms in H_2SO_4 a very dense and firmly adhering film which gives excellent protection. Fe can be protected against rusting by a ferrous oxide film, produced by oxidation of the Fe by H_2O vapor in closed retorts at 700° to 1000° C., or by anodic oxidation in hot electrolytes, or by suspending the articles to be protected in oxidizing salt baths or solutions; this protection is, however, not very lasting. Light metals can be given a very good protection by chemical treatment, most of the many processes consisting in treating the metals with strongly oxidizing solutions, especially chromic acid, or by anodic treatment in oxalic acid as in the Eloxal process. Another method of producing a protective layer is to deposit other metals in form of powder on the surface; sherardizing, calorizing, alitizing and other methods belong to this class which is particularly applied when iron is to be protected against higher temperatures. Recently methods have been applied successfully which deposit a phosphate layer on the metallic surface with a suitable subsequent treatment; the Coslett, Parker and Bonderite processes are particularly useful for the protection of Fe and steel. The proper application of these methods and the pretreatment of the metals and surfaces to be protected are described. Hap (13)

Tests of Regular and Stabilized 18-8 Alloy Welds in Sulphite Liquor. T.A.P.P.I. Materials of Construction Committee, J. D. MILLER, Chairman. *Paper Trade Journal,* Vol. 97, Aug. 31, 1933, pages 29-34. Welded specimens of high C, low C, and Ti stabilized low C 18-8 Cr-Ni-Fe alloys were tested by exposure to sulphite liquors and to acid copper sulphate solutions. Specimens of the regular low C and stabilized low C 18-8 alloys were also tested after having been held at 1200° F. for 200 hrs. Weight loss measurements, microscopic examinations, torsion tests and measurements of changes in electrical resistance were used to determine the extent of corrosion. The following conclusions were reached: 1. The regular low C and Ti stabilized low C 18-8 alloys can be used in the as welded condition without suffering intergranular corrosion by sulphite liquor. 2. The Ti stabilized alloy is resistant to intergranular attack even under the most unfavorable conditions and should be used where the slightest degree of sensitivity to intergranular attack must be avoided. 3. High C 18-8 alloys should always be heat treated after welding and before using in sulphite service. 4. Exposure to boiling sulphuric acid copper sulphate solution provides a relatively rapid method of determining the probable resistance of 18-8 alloys to intergranular attack by sulphite liquor over prolonged periods of service. 4 references with a selected bibliography on intergranular corrosion of Cr-Ni-Fe alloys of 26 references. CBJp (13)

Corrosion-Resistant Ferrous Material in Chemical Engineering. S. WERNICK. *The Industrial Chemist,* Vol. 9, Nov. 1933, pages 378-380; Dec. 1933, pages 445-447. Ten references. A discussion of previously reported work on corrosion resistant steels, their mechanical properties and resistance to chemicals, temperatures and pressures. RAW (13)

Corrosion from Products of Combustion of Gas. Part I. Preliminary Investigations. Joint Research Committee Institute of Gas Engineers & Leeds University. *Gas Engineer,* Vol. 58, Dec. 1933, page 609; *Engineering,* Vol. 136, Nov. 17, 1933, page 558. 33rd report at the 5th Autumn Research Meeting, London, Nov. 1933, states that S acids formed by combustion of S-compounds are the main cause of corrosion but oxides of N and water vapor also have their effect. In all cases deposits contain material derived from the underlying metal of the appliances. Coatings are not as yet sufficiently homogeneous and resistant to afford a permanent protection against corrosion. Deposits in water heaters and central-heating boilers consisted essentially of sulphates or basic sulphates of the metals used, except in the case of cast Fe, when the amount of metal removed was found to be much in excess of that necessary to combine directly with the sulphurous and sulphuric acids. LFM + WH (13)

Erosion Tests of Turbine-Blade Materials. *Electrical World,* Vol. 102, Oct. 7, 1933, page 474. Results of erosion tests of 12% Cr steel with stellite shield, 12% Cr steel, tantalum, 5% Ni steel, and Nitralloy at tip speed of 1000 ft. per sec. are given in tabular form. CBJ (13)

A Yardstick for Wire-Rope Safety. *Power,* Vol. 77, Oct. 1933, pages 524-526. Article based on research by John A. Roebling's Sons Co. in cooperation with Otis Elevator Co. Four factors must be considered in determining strength of used wire rope: Corrosion, broken wires, abrasion and deterioration due to internal wear. Corrosion can not be determined with certainty, but can be prevented by proper lubrication. Broken wires are external and can be found by inspection. Loss of strength from broken wires and the effect of their distribution are shown graphically. Loss of strength from abrasion is obtained by measuring the major axis of the abraded ellipse and reading the value from curves. Graphs are given to correct for service conditions. AHE (13)

Increasing Corrosion Resistance of Light Metals. *Metal & Mineral Markets,* Vol. 4, Dec. 21, 1933, page 3. Corrosion resistance of light metals which depend on an oxide film on the surface may be increased by exposing these metals to the action of ammonia vapors. BHS (13)

Preventing Dangerous Corrosion of Drum Ends. *Locomotive,* Vol. 39, Oct. 1933, pages 226-228. Protecting the ends from collection of dust and soot which, in the presence of moisture, are extremely corrosive to metal, by tight packing between brickwork and drum with asbestos proved very successful. A few practical arrangements are illustrated. Ha (13)

Repairing Drums Weakened by Embrittlement. *Locomotive,* Vol. 39, Oct. 1933, pages 238-239. A seam that had been weakened by caustic embrittlement was repaired by applying wider butt-straps; the cause of the trouble was due to unusually intense water softening. Ha (13)

Some Notes on Corrosion. *Journal of Commerce (Shipbuilding & Engineering Edition),* June 22, 1933, pages 1, 2. Corrosion in ship plates is discussed from various aspects which include removal of mill scale by weathering and chipping, protection with bituminous enamel, electrolytic corrosion between plates and rivets, the use of iron as compared with steel, the effect of vibration, and the time element in the painting of ship hulls. JWD (13)

Corrosion from Products of Gas Combustion. *Iron & Coal Trades Review,* Vol. 127, Nov. 10, 1933, page 714. A preliminary report to the Institution of Gas Engineers deals with corrosion of gas appliances by products of combustion; the latter is due mainly to sulphurous and sulphuric acids formed in the combustion. Analysis of solid corrosion deposits from combustion chambers show that they consist mainly of sulphates of the metals used for the gas appliances. Experiments are suggested and discussed to find means for elimination of this economic loss. Ha (13)

Effect of Composition on the Wear Resistance of Cast Iron (Einfluss der chemischen Zusammensetzung von Gusseisen auf seiner Verschleiss) E. Söhnchen & E. Piwowarsky. *Archiv für das Eisenhüttenwesen*, Vol. 7, Dec. 1933, pages 371-372. Data are given on the wear resistance of cast-iron containing varying amounts of Si, Ni, P, Cr, and Cu, under rolling and sliding friction. In general increased hardness gave higher wear resistance, although there were exceptions to this rule. Pearlitic iron has considerably greater wear resistance than ferritic iron. Wear resistance in rolling friction is increased by greater surface hardness and corrosion resistance. SE (13)

Huckleberry Swamp Corrodes Tower Footing. *Electrical World*, Vol. 102, Dec. 2, 1933, page 735. Tower anchors in a huckleberry marsh were found to be badly corroded. Corrosion extended 2' vertically corresponding to the variation of water level in the marsh. The water was found low in mineral content but high in CO_2 and organic acids. Since the huckleberry bush requires an acid soil, such areas must be closely inspected if tower anchors are to be placed. CBJ (13)

News on Corrosion Prevention (Neues über Rostverhütung) P. Krais. *Wochenblatt für Papierfabrikation*, Vol. 64, Special Number, July 1933, pages 29-30. Reports on experiments carried out in the Deutsches Forschungsinstitut für Textilindustrie on wrought Fe, ingot Fe, steel, Cu and brass in moist air. Moisture deposited on the metal surface due to drop in temperature does not result in rust and patina formation if the CO_2 content of the air has been neutralized by NH_3. This rust inhibiting method can be intelligently employed in many industrial cases since it has been proven that rusting of Fe can be ascribed principally to the presence of CO_2 in air. EF (13)

Corrosion Meeting 1933 (Korrosionstagung 1933) E. Kuhn. *Die Wärme*, Vol. 56, Nov. 25, 1933, pages 773-774. Reviews the papers of Laute (Fatigue and Corrosion), Fry (Intergranular Corrosion in Stainless Steels), Dahl (Corrosion Stability of Bronzes), Schuhmann (Effect of Annealing Treatment on Corrosion Strength of Condenser Tubes), Kühnel (Protective Zinc Plates in Boilers of Rhine Ferry Boats of the German State Railway), Glauner (Correlation Between Dissolving Speed, Solvent and Lattice Forces in Copper Single Crystals) and Meissner (New Tests on Duralplat). Also includes discussion on these papers presented before combined meeting of 4 leading German societies. EF (13)

Corrosion Protection Tests (Korrosionsschutzprüfungen) Herbert Kurrein. *Metallwaren Industrie & Galvano Technik*, Vol. 31, Aug. 1, 1933, pages 295-296. Visual inspection and chemical testing methods will reveal the particularly detrimental presence of pores and flaws in electro-deposits. Corrosion testing methods copying service conditions are discussed emphasizing the salt water spray and the exposure of plated objects to steam containing additions of CO_2 and SO_2. EF (13)

Observations on Corrosion in Low Pressure Boiler Plants (Beobachtungen über Korrosion in Niederdruckdampfheizungsanlagen) E. Neumann. *Gesundheitsingenieur*, Vol. 56, July 8, 1933, pages 315-316. Water heated coils and boilers yield longer service life than steam heated ones. Replacing Fe heating coils by Cu causes intensified corrosion of the Fe boiler due to electrolytic action. If the boiler also consists of Cu, the Fe joints are more severely corroded. Access of atmospheric O_2 to the condensate should be prevented. Filtering through steel wool is suggested. Boiler tubes should always be heated by hot water instead of steam. WH (13)

Boiler Feed-Water Treatment with Special Reference to Corrosion. J. H. Pylus. *Gas World*, Vol. 98, Jan. 7, 1933 (Coking Section), pages 15-18; May 6, 1933 (Coking Section) page 17. Discusses scale, pressure, temperature, lime-soda process of water softening, blow-down systems, zeolite softener, evaporators, de-oiling, dissolved gases, use of sodium carbonate, and colloidal conditioning and outlines the acid and the electrolytic theories of corrosion and shows how the factors influencing the rate of corrosion are related. In the discussion of the use of soda crystals, or soda-ash, and zinc plates, the author says that excess alkalinity encountered with zeolite softened water can be easily overcome by adding the required amount of sulphuric acid. To prevent scale formation sodium phosphate was added, precipitating any calcium and magnesium entering due to condenser leakage, etc., and also inhibiting caustic embrittlement. To reduce the risk of the latter still further, the ratio $\frac{Na_2SO_4}{NaOH} = 4$ was maintained with complete satisfaction. De-aeration of feed-water is also practically essential. MAB (13)

Protection from Corrosion for Aluminium and Its Alloys. N. D. Pullen. *Metal Industry*, London, Vol. 44, Feb. 2, 1934, pages 133-136; Feb. 16, 1934, pages 187-188. Methods available for producing protective films on aluminum besides the naturally formed oxide layer are discussed. The process of Bengough, which permits application of dyes to the coating, chemically produced oxide films with solution of sodium carbonate and sodium chromate, etc., are briefly described. Ha (13)

Fighting Corrosion in Bridge Maintenance. W. R. Roof. *Welding Engineer*, Vol. 18, July 1933, pages 18-20. See *Metals & Alloys*, Vol. 5, Feb. 1934, MA39. Ha (13)

Influences Affecting the Life of Fence Wire and Methods for Prolonging the Service Life of Fence Wire. *Proceedings American Railway Engineering Association*, Vol. 33, 1932, pages 309-310. The life of barbed wire galvanized iron fences averages about 15 years, but when exposed to sea spray or industrial fumes may be reduced to 6-10 years. JCC (13)

Report of Committee XV—Iron and Steel Structures. *Proceedings American Railway Engineering Association*, Vol. 33, 1932, pages 107-108, 673. Following service tests, copper-bearing steel is recommended for railway steel structures liable to corrosion. JCC (13)

Definition of Corrosion Terms. *Proceedings American Railway Engineering Association*, Vol. 33, 1932, pages 260, 767. Appendix A to the report of the committee on Water Service and Sanitation. Definitions are given for grooving, pitting, and embrittlement in locomotive boilers. JCC (13)

Cast Iron Mains in the United States. Hundred Year-Old Pipes Still Serve American Cities. *Gas World*, Vol. 98, Mar. 25, 1933, pages 282-283. Photographs of exhibits which show the resistance of cast iron pipes to solvents. American manufacturers claim that cast iron forms its own protective coating to electrolytic action and corrosive influence of certain acids. A thin coating of surface rust does this. MAB (13)

Gas Furnaces Condition Air To Prevent Rust on Steel Sheets. *Steel*, Vol. 93, Aug. 14, 1933, page 28. Columbia Steel Co., Torrance, Calif., has installed 5 gas-fired warm air furnaces to condition warehouse atmosphere. They are operated automatically to supply heat whenever the combination of temperature and humidity approaches the dew-point. MS (13)

A New Boiler-Water Treatment for the United States Navy. Thorvald A. Solberg & Robert C. Adams, Jr. *Combustion*, Vol. 5, Dec. 1933, pages 24-29. Extensive studies were made on samples of feedwater and scale from 20 naval ships located at widely separated stations. This was followed by comparative trials of the colloidal, coating, electrolytic and chemical methods of feed-water treatment, using 2 600-lb. boilers at the U. S. Naval Engineering Experiment Station. This work was carried out from 1931 to July 1933. A new Navy formula was concocted, consisting of anhydrous disodium phosphate, soda ash and corn starch, in proportions of 47, 44, and 9% respectively. For the 20 years preceding this study, the modified results and boiler compound, as originally specified by Frank Lyon, had been used generally throughout the service. The new work was undertaken in 1931 because of the inability of the Lyon system to cope successfully with modern marine boilers, and due to the many advances made in boiler-water conditioning during the past decade. Four different types of surface were used, namely: (1) as received with mill scale intact; (2) sand blasted; (3) ground to a smooth even surface; (4) ground and polished to give a high surface finish. Only the specimens which had ground surfaces gave results of sufficient consistency to be comparable. DTR (13)

The Question of "Pitting" in Gears (Zur Frage der Grübchenbildung bei Zahnrädern) M. Ulrich. *Zeitschrift Verein deutscher Ingenieure*, Vol. 78, Jan. 13, 1934, pages 53-55. Investigation into the causes of "pitting" in gears showed that the wear is due to alternating stresses at points of contact; pitting is started by fine cracks and not by permanent friction, rusting, etc. Case-hardened steels of German and American make showed the best behavior, refined steel next. Cyanide-hardening retards pitting similar to case-hardening. Ha (13)

Corrosion Protection (Korrosionsschutz) St. Reiner. *Die Wärme*, Vol. 56, Oct. 21, 1933, pages 689-691. Pertains to non-metallic coatings. Removal of rust and grease is stressed. Besides emery, wire brush and sand blasting, chemical means are available such as mixtures of pumice stone powder + aqueous tartaric acid solutions + Zn chloride (or Pb nitrate or Al sulfate), petroleum, warm soap suds, mixture of vaseline oil + oleic acid + emery powder. Grease is nowadays preferably eliminated by trichlorethylene or decaline besides cathodic treatment. (Patented.) The 4 methods of coating by brush, spray pistol, spatula and dipping are dealt with. The following non-metallic coatings and their utilization are fully discussed: (1) oil paint, (2) lacquer, (3) pitch-asphalt-tar, (4) fat and resin, and (5) caoutchouc lacquer coatings. The remarkable corrosion resistance of (3) and (4) are emphasized. Chlor-caoutchouc coatings are not inflammable (airplanes), soluble in carbon tetrachloride, benzol and chloroform, and insoluble in oil, alcohol and water. EF (13)

Resistance of Soldered Joints in Aluminum Cables (Sulla corrosione delle saldature di cavi in alluminio) O. Scarpa. *Alluminio*, Vol. 2, Nov.-Dec. 1933, pages 327-328. Corrosion in 2% NaCl solution of a cable consisting of 40 Al wires in an Al cover, soldered with a solder whose composition was Zn 45, Al 35, Sn 15 has been determined. Sections 20 mm. long of the above, were immersed for 4 months in salt water. A loss of only 0.140 g. was noted, showing that corrosion in this type of soldered cable is not excessive. AWC (13)

Chemical Resistance of Stainless Steels (Die chemische Widerstandsfähigkeit nichtrostender Stähle) Paul Schafmeister. *Metallwirtschaft*, Vol. 12, Dec. 22, 1933, pages 751-755; Dec. 29, 1933, pages 767-768. Resistance to chemical attack of the various grades of stainless steel is due to the formation of a very thin oxide film which passivates the steel. They are not attacked by oxidizing acids such as HNO_3 and aqua regia but are attacked by reagents which destroy the oxide film such as H_2SO_4 and Cl. The oxide film is improved by a smooth, polished surface and by heating the steel to 200°C. The resistance of 18-8 steel to H_2SO_4 is increased by the addition of 2% Mo which raises its passivity and is decreased by cold working, probably due to lower stability of the passivated surface. In the galvanic potential series 18-8 steel stands slightly above Ag. Its loss in weight due to electrolytic action when in contact with Cu and other metals in various electrolytes is very small. When the C content of Cr steels is raised part of the Cr forms carbides and the Cr content of the steel must be raised to compensate for this if equal corrosion resistance is desired. The addition of Ni, Mo, or Cu to Cr steels increases their chemical resistance. Heat treatment also affects the chemical resistance as illustrated by the hardening of Cr knife steel and by heating 18-8 steel to 500 to 900°C. The carbide precipitation at the grain boundaries of 18-8 steel due to heating can be overcome by lowering the C content to less than .07%, by the addition of Ti or V which combine with C, or by reannealing after heating. 23 references. CEM (13)

The Removal and Prevention of Rust. C. R. Liphart. Thesis, University of Pittsburgh, 1933. 48 typed pages and figures, 11 references. Unpublished, available at University of Pittsburgh Library. 34 pages are devoted to a general discussion of corrosion and quotations from various authorities. The aim of the experimental work was to find a solution that would remove rust from rusty steel sufficiently to leave it in good condition for painting. Twenty-five solutions were tried, applied by brushing, left 5 to 8 minutes, during which the most heavily rusted spots were rubbed with steel wool or a steel brush, normally rusted areas being left undisturbed, and the solution and rust then wiped off with a cloth. Evaluation was made not only on the basis of ease of rust removal but also on the speed with which rust was again formed on the cleaned surface carrying a film of the solution. One of the preferred solutions contained 45 g. ferric sulphate, 25 g. zinc chloride and 200 cc. of phosphoric acid in a liter. Others, nearly equal in effectiveness, omitted the zinc chloride and contained a little more of the other 2 chemicals. To some such solutions 5 g./liter of copper sulphate was also added, to produce a copper film for further rust protection. This was also used in a solution containing also 10 g./liter of stannic chloride and 200 cc./liter of phosphoric acid, which was found effective. Higher concentrations of stannic chloride, the use of aluminum sulphate instead of ferric sulphate, and the addition of tartaric acid, sugar or glycerine to various solutions of phosphoric acid plus one or more of the salts mentioned, did not give better results. The evaluation of the behavior of the solutions, upon various available rusty samples, could hardly be made quantitative, the results being judged visually. HWG (13)

Corrosion Test of Heat-resisting Steel, 18:8 Type, With Various Additions. V. Kuznetzoff & I. Liferenko. Thesis, Carnegie Institute of Technology, 1933. 24 typed pages, 7 tables, 6 figures, 13 references. Unpublished, available at Carnegie Institute of Technology Library. Loss of weight was determined after 50 hrs. in 20% H_2SO_4 at 25°C., or after each of 2 periods, of 48 hrs. each, in 4% HCl (10% solution of strong HCl in H_2O), at 25°C. The alloys contained about 18% Cr, 8% Ni, 0.06 to 0.11% C (usually close to 0.10%) with and without added elements, alone or in combinations. Added elements used were Cu, V, Ti, Mo, W. One steel had 0.11% Te beside W and Ti. These steels have previously been studied at Carnegie as to decomposition and changes in impact resistance by thermal treatment. 1.5% Mo greatly reduced corrosion in both acids, while W did not. The beneficial effect of Mo was still further enhanced by adding 1 to 2.5% Cu. Increase in Mn to 3% in presence of Mo and Cu was not harmful. Increasing Ni from 8 to 12% improved corrosion resistance in these acids. V, Ti and Te were not found beneficial. The Ti content used was rather low. For the alloys used, a quenching temperature of 2100°F. gave best results. On the basis of tests in both acids an alloy showing better corrosion resistance than plain 18-8, contained 17.7% Cr, 8% Ni, 0.11% C, 2.6% Cu, 2.8% Mo, quenched from 2100°F. An alloy of 18.1% Cr, 7.9% Ni, 0.06% C, 1.45% Mn, 1.1% Cu, 1.5% Mo acted much the same. One with 1.5% Mo was better than 18-8, but the further addition of Cu seemed to be helpful. No alloy containing Cu without Mo was tested. HWG (13)

Corrosion Resistance of High Purity Fe-Cr-Ni alloys in boiling HNO_3. C. W. Schuck. Thesis, Carnegie Institute of Technology, 1933. 31 typed pages, 4 figures, 10 references. Unpublished, available at Carnegie Institute of Technology Library. The Huey test for stainless steels, boiling in HNO_3 for 5 periods of 48 hrs. each and taking loss of weight, was shortened by using only one 48 hr. period, after tests that indicated that the increase in corrosion rate in periods after the first was so slight that the first period only should be sufficient for any but the most fine-haired evalution. Alloys of 12 to 27% Cr and 12 to 22% Ni, with but 0.01 or 0.02% C, others with 18% Cr, 4 and 12% Ni and 0.04% C, an alloy of 28% Cr, 0.20% C, and some of 18-24% Cr, 12-19% Ni and 0.10-0.18% C were tested, as cast, forged, and after varying heat treatments. Results indicate that 12% Cr is too little for corrosion resistance. Resistance to HNO_3 was enhanced by suitable Ni content, contrary to some prior opinion, in those cases where the Ni made the alloys fully austenitic. Decomposition by thermal treatment producing a magnetic phase made them less resistant to attack, due to heterogeneity. Carbon was detrimental, by binding chromium and by producing heterogeneity. The conclusions as to corrosion resistance are not carried to any other set of conditions than boiling in HNO_3. HWG (13)

Chemical Embrittlement of Boiler-Plates. L. W. Schuster. *Mechanical World & Engineering Record*, Vol. 93, Aug. 18, 1933, pages 792-795. See *Metals & Alloys*, Vol. 5, Jan. 1934, MA 6. Ks (13)

A Preliminary Note Upon the Germicidal Activity of Silver Amalgams. J. PAUL WINTRUP. *Dental Cosmos,* Vol. 75, No. 10, Oct. 1933, pages 946-947. Amalgams were titrated and rubbed in the hands as in preparation for inserting into tooth cavities; one set of specimens was left in sterile tubes for 48 hr. before culturing; another was cultured immediately, and a third was washed with phenol and then cultured. Only 2 positive growths were obtained from 65 cultures. 1 Wintrup concluded: (1) Amalgam exerts definite germicidal action against organisms of the air and hands; (2) Phenolization of the cavity, it would appear, while apparently unnecessary, gave perfect protection against contamination of a cavity from extraneous organisms introduced into the amalgamated mixture. OEH (13)

Metals and Condensed Milk, Corrosion of Metals in Manufacture of Evaporated and Sweetened Condensed Milk. E. C. THOMPSON, R. P. MEARS, H. E. SEARLE & F. L. LAQUE. *Industrial & Engineering Chemistry,* Vol. 25, Dec. 1933, pages 1311-1316. The corrosion of metals in the manufacture of condensed and evaporated milk was studied by exposing metal specimens in equipment in operation. Extent of corrosion was determined by measuring the weight lost by each specimen and by examining it visually. Corrosion was most active in evap- 2 orators, hot wells, drop tanks, and preheaters. Estimated Cu pick-up from typical evaporators was 2.5 p.p.m. for condensed and 1.6 for evaporated milk. At every point of test the resistance of Cu was surpassed by other metals of good physical and fabricating properties. The metals used and their compositions are given. Hard films of protective nature form on the metals in certain equipment. 19 references. MEH (13)

The Electrolytic Oxidation of Aluminum with High Frequency Currents. A. F. VALTER, S. S. GUTIN, T. G. LYAPUNOVA & P. V. STEPANOV. *Zhurnal Fizicheskoi Khimii* (Journal of physical chemistry). T. IV, issue 3, 1933, pages 295-298. (In Russian.) The electrolyte used was a preparation of H_2SO_4 and $(COOH)_2$. 3 frequencies were experimented with: 500, 13000 and 10^6 cycles/second. No difficulties were met with 500 cycles. 2 curves show: break- 3 down voltage against applied voltage and break-down voltage against current density. Best results were obtained either with .005-.05 amp/cm.^{2} or around .5 amp/cm.^{2}. The break-down tension was 350-450 volts. The applied tension varied between 50-200 volts, and a slight drop of the break-down voltage can be seen as the tension increases. The oxidized film appeared mechanically more elastic than when formed at 50 cycles. With a 13000 cycle current only plates narrower than .5 cm. could be oxidized directly. With 2.5-3 amp./cm.^{2} oxidation is uniform and has a break-down resistance of 300-350 volts. The elastic quality of the film is superior to the same of the previous experiment. A preliminary oxidation for a short period with a 50 cycle current was necessary if the plates were wider than .5 cm. The film was irregular in appearance and in resistance. With 10^6 cycles no positive results were obtained. The voltage across the bath was insignificant, 4 although 1.5 amps. were used, and the tension across some of the parts of the circuit reached 1500 volts. MJC (13)

Consistent Data Showing the Influence of Water Velocity and Time on the Corrosion of Iron. R. F. PASSANO & F. R. NAGLEY. *Preprint* No. 27, *American Society for Testing Materials,* June 1933, 13 pages. With temperature, oxygen concentration, composition of water, area of specimen, surface condition of specimen, and composition of metal controlled, the influence of water velocity and time were studied in an immersion corrosion test. Successive experiments were conducted at intervals between 1 and 60 days at a velocity of 1 meter per min., between 1 and 30 days at 2 meters per minute, and between 1 and 15 days at 5 meters per minute. (The velocity range therefore was from .05 to .27 ft./sec.) Iron 5 loses weight in direct proportion to time at the beginning of the tests. Duration of this initial period decreases as the velocity is raised, and is probably a hyperbolic function of the velocity. Following the initial period, iron loses weight in proportion to the logarithm of time under the conditions of these tests. From the relative position of the logarithmic portions of the loss in weight-time curves, the conclusion is drawn that the curves representing the various velocities will cross. Thus, the loss of weight from iron specimens increases with velocity for a time, but in the end the specimens exposed at high velocities will probably lose less weight than those exposed at low velocities. VVK (13)

Corrosion Phenomena in Tar Stills (Korrosionserscheinungen an Teerdestillierblasen) Report 220 of the Materials Committee of the Verein deutscher Eisenhüttenleute. 6 *Stahl und Eisen,* Vol. 53, July 13, 1933, pages 734-746. Various examples of corrosion are dealt with. Corrosion at punched rivet holes can be overcome by annealing or using welded seams, but not by the use of a non-aging steel alone. For pure phenol distillation a sprayed coating of Al proved a good corrosion preventive. Ammonium chloride and moisture in the tar appear to be the corroding agents. Loss in weight in laboratory tar distillation tests of various low C steels containing moderate amounts of Mn, Al, Mo, Cu, and Cr, are tabulated; no very marked differences between the steels are shown. A coating of lime reduced the corrosion loss of a low carbon steel from 7.1 to 3.3 mg./cm.^{2}. SE (13)

The Corrosion-Time Relationship of Iron. R. F. PASSANO. *Industrial & Engineering Chemistry,* Vol. 25, Nov. 1933, pages 1247-1250. Paper pre- 7 sented at the Third Corrosion Conference, Bureau of Standards, Washington, D. C., March 1933. The author is of the opinion that the use of calculated rates of corrosion is likely to be misleading except when the corrosion-time relationship is linear or when one has a knowledge of the nature of the corrosion-time relationship existing under the particular conditions, whatever they may be. Various types of corrosion are presented graphically in their relationship to time. 13 references. MEH (13)

Use of High Chromium Alloy Castings in the Construction of Chemical Equipment (Hochlegierter Chromguss als Werkstoff im chemischen Apparatebau) K. ROESCH & A. CLAUBERG. *Die Chemische Fabrik,* Vol. 6, July 26, 1933, pages 317-320. Alloys of various Cr and C contents were tested for corrosion resistance by the Duffek method, in which the potential drop between the sample 8 in 0 atmosphere and a Hg electrode is measured over a 24 hour period. Suitable alloys for chemical equipment are those which can be cast and are corrosion resistant without being hardened. The C content must be fairly high to make casting possible and this necessitates a high Cr content. 28 to 32% Cr with 1% C has been found best. This alloy consists of ferrite with Fe-Cr double carbide. If the C is raised the Cr must also be raised. The alloy resists HNO_3, organic acids, alkalies and many other chemicals, but not HCl. The addition of other metals further improves corrosion resistance. It has 35-40 kg./mm.^{2} tensile strength, 270 Brinell hardness, and 7.4 specific gravity. Its coefficient of expansion is similar to steel and cast iron. It can be welded and it is not necessary to heat-treat the castings after welding. It does not scale up to 1230° C. The addition of Ni in- 9 creases the creep strength at elevated temperatures. Many industrial applications are pictured. CEM (13)

Hard Facing and Fabrication in the Dredging Industry. D. LLEWELLYN. *Welding Engineer,* Vol. 18, Nov. 1933, pages 15-18. Reclaiming of worn equipment by hard-facing and building-up parts of buckets, pipe fittings, dredge cutters, etc., results in considerable savings and longer life of machinery. Fabrication by torch-cutting from steel plates and welding together is feasible. Examples are shown. Ha (13)

Effect of Sulphur and Phosphorus on the Corrosion of Iron. L. TRONSTAD & J. SEJERSTED. *Iron & Coal Trades Review.* Vol. 126. May 26. 1933. pages 825-827; *Foundry Trade Journal,* Vol. 48, June 15, 1933, pages 413-415. 10 Paper read before annual meeting of Iron & Steel Institute. See *Metals & Alloys,* Vol. 4, Oct. 1933, page MA 311. OWE + Ha (13)

Soil Corrosion in Underground Pipe Lines. *Commonwealth Engineer,* Vol. 21, Aug. 1, 1933, page 14. An editorial survey mainly based on recent publications of W. Denman, S. Gill and J. H. Cameron. WH (13)

Practical Hints on Corrosion Elimination in Hot Water Plants (Praktische Winke für die Beseitigung von Korrosionen in Warmwasserversorgungsanlagen) PH. RITTER. *Gesundheitsingenieur*, Vol. 56, Dec. 9, 1933, page 587. A flocculent suspension causing turbidity in a hot water plant of a Berlin "skyscraper" was noted after 3 months operation. The high-pressure installation was built in Cu. Flushing eliminated the source of trouble for only 2 months. Careful inspection revealed severe corrosion attack in a cast Fe pump housing. The rotor wheels were made of bronze. Sand blasting and spraying the interior of the pump with bronze according to the Meurer method remedied the corrosion. There has been no water turbidity for the last 2 years. Writer suggests utilization of the metal spray process to "enoble" cheaper material by means of a Cu or bronze coating. WH (13)

Pipe Corrosion and Pipe Protection. AMOS H. ABBOTT. *American Gas Journal*, Vol. 140, Jan. 1934, pages 9-11. Information from the soil corrosion studies of the Bureau of Standards is discussed. Tabulated data shows that rates of loss in weight and the depth of pitting have maximums during the first few years and decrease consistently. The relative merits of protective coatings were studied by electrical tests and visual inspection. The coatings included the following groups: cut backs, asphalt emulsions, greases, enamels, organic reinforced coatings and asbestos felt reinforced coatings. Cathodic pipe protection is briefly considered. CBJ (13)

Decomposition of Water by Metalloids (Sur la décomposition de l'eau par les métalloïdes) J. COMPARDOU. *Bulletins de la société chimique de France*, Vol. 53/54, Aug./Sept. 1933, pages 986-992. Considers the reaction of the following groups of elements with water: (1) F, Cl, Br, I; (2) O, S, Se, Te; (3) N, P, As, Sb; (4) C, B, Si. The analogous behavior of Si at one end and of the metals such as Al, Cr, Zn, etc. at the other is pointed out. EF (13)

Solution Speed of Electrolytic Zinc in Acids (Lösungsgeschwindigkeit des elektrolytischen Zinkes in Säuren) M. CENTNERSZWER & M. STRAUMANIS. *Zeitschrift für physikalische Chemie*, Abt. A, Vol. 167, Jan. 1934, pages 421-430. The rate of solution of chemically pure Zn prepared electrolytically is lower in dilute acids than non-electrolytic Zn ("Kahlbaum") and sublimed Zn, and is about the same as Zn containing 0.2% Cd. The rate of solution of ground Zn plates starts at a maximum, drops rapidly and attains a limiting value characteristic for metal and acid. Electrolytic Zn dissolves faster in HCl than in H_2SO_4 of the same H-concentration. There is no interrelation between the solution speed of Zn and the current density at which it had been deposited. EF (13)

Corrosion of Metals in Electro Plating (Die Korrosion an den Metallen der Elektrotechnik) FRANZ DEUTSCH. *Metallwaren Industrie & Galvano Technik*, Vol. 31, Aug. 15, 1933, pages 322-324. Calling attention to the electromotive series, the mechanism of corrosion of metal parts in electroplating installations is discussed and methods of corrosion prevention briefly considered. EF (13)

Comparative Resistance of Certain Commercial Ferrous Materials to Corrosion by Gaseous Hydrogen Sulfide. JOHN M. DEVINE, C. J. WILHELM & LUDWIG SCHMIDT. *American Institute Mining & Metallurgical Engineers, Technical Publication* No. 531, Feb. 1934, 16 pages. Specimens of different ferrous materials in the form of 2-in. disks were placed in watersoaked bags and exposed to natural gas for 24 hr. The H_2S content of the gas was either 2.45 or 3.16 grains per 100 ft.^{3}; the O content was approximately 1%. After exposure scale was removed by polishing and the loss in weight determined. Alloys of the stainless type were not attacked. The attack of a 5% Cr steel was intermediate between that of the ordinary ferrous materials and the stainless alloys. An austenitic Ni-Cu cast Fe had a resistance less than that of the 5% Cr alloy but greater than that of ordinary steel. There was not an appreciable difference in attack of unalloyed materials and low-alloy steels. 7 references. JLG (13)

General Considerations on Treatment of Boiler Waters of Power Stations (Considérations Générales sur le Traitement des Eaux de Chaudières des Centrales) F. DROUIN. *Science et Industrie*, Vol. 17, Jan. 1933, pages 21-25. Report of Committee "Grandes Stations Centrales Thermiques Modernes" (Large Modern Thermal Power Stations). Different methods to be resorted to in each special case for preventing corrosion and scaling of boilers are discussed. A section of the article deals with well known phenomenon of caustic embrittlement. FR (13)

Destruction of Pipe Lines in a Hospital by Stray Currents (Zerstörungen von Rohrleitungen durch vagabundierende Ströme in einem Krankenhause) W. FRANKENSTEIN. *Gas- und Wasserfach*, Vol. 76, Dec. 30, 1933, pages 394-396. In the municipal hospital of Fürstenwalde/Spree which had been equipped with a new gas, water and steam pipe system in 1925, pipe fracture occurred after one year's service, and such failures repeatedly occurred after repair. Failures were due to stray currents caused by an adjacent transmission line and a power cable. These stray currents were reduced to a minimum by a special type of grounding. GN (13)

I—The Atmospheric Corrosion of Different Kinds of Iron and Mild Steel Wire (Rostning i Luft av Olika Slags Järntraad) JOHN GREGER. **II—Corrosion Tests on Iron and Mild Steel Wire by Spray Method (Rostningsförsök paa Järntraad Medelst Spray Metod)** ERIK J. VIRGIN. *Report* No. 58 by *Swedish Institute of Testing Materials*. (Statens Provningsanstalt, Stockholm.) 1933, 18 pages. See "Comparison of the Rusting Tendency of Lancashire Iron, Soft Martin and Electric Steels in Telegraph Wires, *Metals & Alloys*, Vol. 5, Jan. 1934, page MA 4. BHS (13)

Corrosion of Light Alloys (La corrosione delle leghe leggere) G. GUZZONI. *Alluminio*, Vol. 2, Nov.-Dec. 1933, pages 329-336. A review of the electrochemical theory of corrosion and the results of studies on the corrosion of Al and alloys, such as, Alclad, Allautal, Duralite, Vedal, etc. AWC (13)

Mechanism of Corrosion of Iron in Sodium Chloride Solution. Effect upon the Potential of the Iron of Adding Organic Substances to the Brine. E. G. R. ARDAGH, R. M. B. ROOME & H. W. OWENS. *Industrial & Engineering Chemistry*, Vol. 25, Oct. 1933, pages 1116-1121. A procedure is described by which reproducible measurements of the potential of an Fe electrode in a brine can be obtained. This procedure is employed in making a survey of the inhibiting effect on the corrosion of Fe in brine of different classes of organic compounds which are shown to have a strong tendency to inhibit the corrosion of Fe. The mechanism of this inhibiting action is partially elucidated. MEH (13)

Passivity Phenomena in the Solution of Copper in a Mixture of Nitric and Sulphuric Acid. A Contribution to the Knowledge of Polishing Pickles (Passivitätserscheinungen bei der Auflösung von Kupfer in einer Mischung von Salpeter- und Schwefelsäure. Ein Beitrag zur Kenntnis der Glanzbrenne) A. KUTZELNIGG. *Zeitschrift für Elektrochemie*, Vol. 39, Feb. 1933, pages 67-73. Cu becomes passive in a few seconds in a mixture of 1 vol. HNO_3 of 1.4 sp.gr. and 1 vol. of H_2SO_4 of 1.84 sp.gr. at 30°C. This is due to the formation of a protective layer of $CuSO_4$ pentahydrate. Increase of temperature favors, moderate addition of H_2O delays the passivation. HCl prevents passivation but only if no soot is present. 19 references. Ha (13)

Corrosion of Metals and Alloys (La Corrosion des Métaux et Alliages) J. JACQUART. *Science et Industrie*, Vol. 16, Nov. 1932, pages 449-458; Dec. 1932, pages 515-521; Jan. 1933, pages 13-15. The first section discusses the theoretical aspects of corrosion and corrosion testing. The theories discussed are: (1) Catalysis (a) directly through CO_2, (b) indirectly through H_2O_2, (c) through colloids. (2) Physical catalysis through an initially formed active film. (3) Biological theory. (4) Electrochemical theory. The latter being almost universally accepted is studied at length. Following, corrosion tests, particularly accelerated tests are dealt with. Second section of article is devoted to industrial processes for protection against corrosion and is divided into 3 headings: (1) Selection of metal or alloy for a given use. (2) Protection by paints and coatings. (3) Special means for protection against corrosion in some particular industries. Among the latter can be cited (a) provision for excess thickness of material to provide for corrosion, (b) preliminary treatment of piped water, (c) Special treatments for boiler water, (d) means of protection against soil electrolysis. FR (13)

Corrosion of Central Hot Water Plants (Zur Frage der Verrostung von zentralen Warmwasseranlagen) ALEX. MARX. *Gesundheitsingeneiur*, Vol. 56, Oct. 14, 1933, pages 481-483. Discussion on the danger of corrosion in high and low pressure hot water plants and criticism on recent findings of Daeves & Grosschupff (*Deutsche Klempnerzeitung*, 1932, page 1032). It has been definitely established that corrosion attack in high pressure installations is materially greater than in low pressure ones. Otherwise the former show striking advantages over the latter and Marx suggests deaeration by installing a reducing valve together with a manometer and 3 way cock into the pipe line before entering the hot water reservoir. The author stresses the importance of deaerating the water before heating. WH (13)

The Effect of Sewage on Cast-Iron Venturi Meters. C. E. KEEFER. *Engineering-News Record*, Vol. 112, Jan. 11, 1934, page 46. Domestic sewage free from gritty material and not flowing at excessively high velocities was found to have little disintegrating effect on cast iron. CBJ (13)

Control of Feed Water for Steam Generators (La Surveillance de l'Eau d'Alimentation des Générateurs à Vapeur) J. M. HELVÉ. *La Revue Industrielle*, Vol. 63, Jan. 1933, pages 19-25. Methods of determining quality of water in order to prevent corrosion of generators are discussed. FR (13)

Corrosion Research on Light Metals. FREEMAN HORN. *Iron & Coal Trades Review*, Vol. 126, Feb. 24, 1933, page 293; *Metal Industry*, London, Vol. 42, Feb. 10, 1933, pages 173-176; Feb. 17, pages 197-199; Mar. 3, pages 253-254. See *Metals & Alloys*, Vol. 4, Dec. 1933, page MA 380. Ha (13)

Effect of Pressure on the Attack of Hydrogen Sulphide on Steels. E. DITTRICH. *Fuel in Science & Practice*, Vol. 12, Nov. 1933, pages 383-389. See *Metals & Alloys*, Vol. 4, Oct. 1933, page MA 310. DTR (13)

Research on Behaviour of Steel Mains Toward Corrosion. F. EISENSTECKEN. *Gas World*, Vol. 98, Apr. 22, 1933, page 382. Abstract of article published in *Gas und Wasserfach*, Vol. 76, 1933, pages 78-84. See "Recent Investigation on the Behavior of Steel Tubes under Strong Corrosion Attack." *Metals & Alloys*, Vol. 4, page MA 344. GN + MAB (13)

Electrolytic Corrosion in Gas Mains. W. BECK. *Gas Journal*, Vol. 202, June 7, 1933, pages 720-721, 747-750; Vol. 203, July 5, 1933, page 47; *Gas World*, Vol. 98, May 27, 1933, pages 547-548; June 3, 1933, pages 584-594; *Engineering*, Vol. 135, June 9, 1933, pages 617-618. See "Examination of New Pipe Coverings Exposed to the Influence of Electric Currents, Low Temperature and Vibration Stresses," *Metals & Alloys*, Vol. 5, Mar. 1934, page MA 113. LFM + MAB (13)

Is Service of 18-8 Forecast by Copper Sulphate Test? V. B. BROWNE. *Steel*, Vol. 93, July 17, 1933, pages 23-26. See "Does the Krupp Test Forecast the Life of 18-8?", *Metals & Alloys*, Vol. 4, Oct. 1933, page MA 311. MS (13)

Intergranular Corrosion of Austenitic, Stainless and Chrom-Nickel Steels (Nagot om korngränsfrätning hos austenitiska, rosthärdiga krom-nickelstal) GUNNAR LINDH. *Jernkontorets Annaler*, Vol. 117, Nov. 1933, pages 530-553. Bibliographic summary of previous work. Conclusions reached are that carbon separation and intergranular corrosion may be minimized by (a) lowering the carbon content, (b) increasing the solubility of carbon in austenite at room temperature, (c) addition of carbide forming metals, (d) producing a second phase (delta ferrite) along with austenite, (e) precipitation of carbides by gentle heat treatment, and (f) shortening the time of tempering. Several contradictory points are noted in the literature. 17 references. HCD (13)

Remarkable Deterioration of Lead Drain Pipes and Its Elimination (Beachtenswerte Zerstörung von Blei-Abwasserröhren und ihre Lehren) F. LINKE. *Gesundheitsingenieur*, Vol. 56, July 29, 1933, page 360; *Zeitschrift für das Krankenhauswesen*, 1933, No. 2, page 29. Sn and Sb bearing Pb (scrap metal from cable industry) was utilized for drain pipes in a hotel. Due to an insufficient inclination, the pipes were always only partly filled with waste water. Only the upper half of the pipes were severely corroded. Pits of 3-10 mm. diam. are ascribed to local attack of drops which were suspended at the upper tube wall and which were lower in NaCl (below 10 mg. NaCl/l.) than the rest of the waste water. A higher NaCl concentration involves less corrosive action. Smaller pipe sizes are suggested as a remedy besides more frequent flushing. WH (13)

Corrosion and Corrosion Protection in Boiler Plants (Korrosion und Korrosionsschutz im Dampfkesselbetrieb) F. KROEMER. *Die Wärme*, Vol. 56, Dec. 9, 1933, pages 798-801. Paper at the Fachschau für Bau- und Werkstoffschutz, Essen, 1933, points out by 6 representative illustrations corrosion defects due to mechanical stresses in condenser tubes, caustic embrittlement and cold deformation around rivet holes, intercrystalline crack formation, oxygen corrosion in condenser tubes, "gas" corrosion on economiser flange, and corrosion underneath boiler linings. A condenser tube was locally cold deformed on purpose by a few light hammer blows and installed. Corrosion started at the worked regions. Reviewed at length are the means of protection based on a list of 28 literature citations appended. EF (13)

Relation between Solution Velocity, Dissolving Agent and Lattice Forces in Copper Monocrystals (Ueber den Zusammenhang zwischen Lösungsgeschwindigkeit, Lösungsmittel und Gitterkräften bei Kupfereinkristallen) R. GLAUNER. *Oberflächentechnik*, Vol. 19, No. 24, 1933, page 282 To find the laws according to which metallic monocrystals are dissolved (as function of velocity in crystallographic directions, chemical nature of dissolving agent) is of great importance for elucidation of corrosion phenomena. Monocrystals of baser metals than H do not show a great difference of solution velocity in the different crystallic directions, but this is not true of metals nobler than H. The mechanism of solution was investigated on the Cu-monocrystal. The temperature coefficient of solution velocities is much greater than that of diffusion velocities; this is explained by surface forces emanating from the crystal lattice. Ha (13)

Extending Service Life of Chromium Plating Vats (Verlängerung der Lebensdauer von Verchromungswannen) FELIX ZABEL. *Metallwaren Industrie & Galvano-Technik*, Vol. 31, July 1, 1933, pages 255-256. Pure CrO_3 only slightly attacks Fe tanks. Electrochemical effects are of greater importance. In welded tanks galvanic cells are formed which might result in complete destruction of the vat. Overlapped riveted, caulked and only externally welded seams should be employed. Injured Pb linings bring the couple Fe/Pb into play. Further possibilities of electrolytic attack are discussed. EF (13)

Requirements and Testing of Sheet Zinc for the Manufacture of Batteries (Über die Anforderungen an Zinkblech für die Batterieerzeugung und dessen Prüfung) E. ZALESINSKI. *Metallwirtschaft*, Vol. 12, Dec. 1, 1933, pages 699-704. Corrosion of sheet zinc used for the container and the negative electrode of dry cells is affected by the purity of the metal. Pb and Cd are not harmful; Cu, Fe, Sb, and As increase corrodibility of Zn in the order given. Influence of impurities is less if Zn has been quenched so that impurities are in solid solution. If impurities are segregated, such as at the top of an ingot, they are more harmful. Cast Zn is attacked more than annealed rolled Zn and still more than hard rolled Zn. Corrosion is also affected by the surface condition of the metal. Most of the methods for testing the suitability of Zn for dry cells consist in determining the temperature rise of acid in which it is dissolved or the loss in weight of the Zn. A more accurate method proposed consists of measuring the volume of H liberated after 20 or 30 minutes when a sheet Zn sample of 25 cm.^{2} surface is immersed in 100 cc. 10% H_2SO_4. The apparatus for this test is described. This and the temperature rise test were made on several grades of Zn and it was found that Zn suitable for dry cells should not liberate more than 80 cc. H in 20 minutes or more than 200 cc. in 30 minutes. These tests indicate the behavior of Zn while the battery is not in use, but while the current is flowing the amount of corrosion depends on different factors. Formerly most battery cups were made from a cylindrical shell with a soldered seam and a bottom soldered on with Sn-Pb solder. Due to the local cells set up the soldered seams corrode first. Sweated cups corrode much less at the seams. Seamless cups made by cold drawing or cold extruding are much superior from the standpoint of corrosion. 38 references. CEM (13)

Effect of Light on the Corrosion of Steel in Aqueous Solutions. HIKOZO ENDO & HARUJIRO SEKIGUCHI. *Kinzoku no Kenkyu,* Vol. 10, Apr. 1933, pages 166-178. Many specimens of various copper bearing mild steels were suspended by glass hooks in glass bottles; one specimen being hung in each bottle. The bottles were filled with various aqueous solutions; some of them were fully exposed to diffused light and others slightly exposed. The weight loss of specimens 1
in dilute acidic solutions, such as nitric acid, acetic acid or ferric chloride solution was always found to be greater in the former case than in the latter. The effect of light was explained as follows:— In the case of dilute acetic acid solution, the following reaction takes place.

$$2Fe + 4CH_3COOH \rightarrow 2Fe(CH_3COO)_2 + 2H_2$$

In the presence of oxygen, the next reaction takes place:

$$4Fe(CH_3COO)_2 + 4CH_3COOH + O_2 \rightleftarrows 4Fe(CH_3COO)_3 + 2H_2O$$

If the ultraviolet ray changes ferric salt into ferrous condition, as W. H. Ross says, the second equation proceeds from right to left and forms acetic acid. Thus the corrosion of steels was accelerated by the first equation. In the case of dilute nitric acid solution, the following two reactions take place. 2

$$Fe + 2HNO_3 \rightarrow Fe(NO_3)_2 + H_2$$
$$Fe(NO_3)_2 + H_2 + 2HNO_3 \rightleftarrows Fe(NO_3)_3 + NO + 2H_2O$$

If ultraviolet ray decomposes ferric salt into ferrous one, the second equation proceeds from right to left and forms nitric acid, which corrodes iron as shown by the first equation. KT (13)

Lead Plating as Protection from Corrosion (Galvanische Verbleiung als Korrosionschutz) H. KURREIN. *Zeitschrift Verein deutscher Ingenieure,* Vol. 76, Mar. 19, 1932, page 300. The great advantages of Pb plating for specific cases are pointed out, but as Pb is electronegative to Fe, the latter would corrode if the Pb coating can not be made absolutely dense, without pores, and firmly adherent. Of the 3 possible depositions of Pb on Fe, solid Pb, crystalline Pb and 3
spongy Pb, only the first one is suitable. The content of hydrogen of electrically deposited Pb makes it very corrosion resisting. A few good Pb baths are given. Pb plating has proved very useful for bridges over railways where the S containing smoke of the locomotives quickly corrode the bottom of the bridges. Several examples are given. The very intimate adherence of the Pb on the Fe also eliminates the creeping of the Pb which often occurs in Pb covered tools. The strength of adherence is 120 kg./cm.² against 38 kg./cm.² of Zn for hot-galvanized Fe. A thickness of 0.001 mm. can be considered a good protection. Ha (13)

Intercrystalline Corrosion in Stainless Steels (Die Interkristalline Korrosion in rostfreien Stählen) SCHAFMEISTER. *Oberflächentechnik,* Vol. 10, Dec. 19, 1933, pages 287-282. Intercrystalline attack follows the grain boundaries and 4
can be observed in Pb, Sn, Al, brass, mild steel and stainless steels. Dezincing and season cracking of brasses, lye-brittleness of mild steel and the intercrystalline disintegration of austenitic stainless steel are most frequently observed phenomena. The conditions under which these materials are attacked can be represented in the following table:

	Brass—Intercrystalline Corrosion by dezincing	by tearing	mild steel	18% Cr, 8% Ni
Weak corroding agent	+	+	+	+
Small inclusions at the grain boundaries	+	0	+	+
Macro-tensile stresses	0	+	+	0
Micro-tensile stresses	0	0	0	+	5
Plastic deformation	0	0	–	– –

where + means necessary, 0 favorable, – not necessary, – – retarding. Grain boundary corrosion is an electrochemical process. Macro-tensile stresses are proper (interior) stresses due to deformation, cooling, temperature differences; micro-tensile stresses can not be experimentally demonstrated, they are in equilibrium (dislocation of the lattice). Greater irregular plastic deformation (tensile stress) favors corrosion. Austenitic steels can be improved by preventing segregation of carbide by addition of Ti in the ratio of about Ti/C = 4/1; 0.14 C and 0.47 Ti gave very good results. Disintegration of grain boundaries can also be prevented or retarded by increasing Cr and decreasing Ni, addition of Ti, Si, etc., which form mixed structures which are more difficultly attacked. The phenomenon needs further 6
study. Ha (13)

Cylinder Wear. C. G. WILLIAMS. *Automobile Engineer,* Vol. 23, July 1933, pages 259-264. Report issued by the Research and Standardization Committee of the Institution of Automobile Engineers. Composition of the cylinder bore material was: total C—3.57%, combined C—0.85%, Si—1.2%, P—0.53%, Mn—0.9%. At a cylinder wall temperature of 50°C. if the S content of the fuel was increased from 0.03% to 0.2% cylinder wear was increased from 0.001 to 0.0087 in. and top ring wear from 0.005 to 0.029 in. per 1,000 miles. Piston rings indicate that corrosion was responsible for the additional wear. Organic acids also caused wear by corrosion. Austenitic cast-iron containing 14 to 15% Ni, 6 to 7
7% Cu, and 2 to 4% Cr has a greater resistance to corrosion than ordinary cast-iron. Austenitic cast-iron piston rings showed a substantial reduction in both ring and cylinder wear. Further experiments will be carried out in which cylinder walls will be of austenitic cast-iron, Cr plated, 34% Cr cast-iron, and nitricastiron. RHP (13)

Tube Corrosion in the Sugar Industry (Rohrkorrosion in der Zuckerindustrie) *Gesundheitsingenieur,* Vol. 56, Dec. 16, 1933, page 608. Note on experiences of Hohler who established by comparative service tests that brass is the most severely attacked material while special brass was 23% and bronze 49% more resistant. Mild steel was best under conditions applied, but has disadvantage of being attacked by moisture and O_2 during idling. Hot-worked non-ferrous metals were more stable than cold-worked metals. WH (13) 8

Corrosion of Condenser Tubes in the Sugar Industry (Die Korrosion von Kondensatorrohren in der Zuckerindustrie) WUESTNER. *Oberflächentechnik,* Vol. 10, July 4, 1933, pages 157-158. Apparatus used in the sugar industry is subject to mechanical stresses, chemical attack (vegetable acids, fermentation products, alkalies, etc.) and thermal stresses (80°-100°C.). Experiments have shown that wrought iron is very resistant with brass a good second. Hot-worked materials show greater resistance to corrosion than cold-worked. Corrosion is more rapid during the idle season than during the sugar campaign. Ha (13)

Chemical Composition and Corrosion. H. SUTTON. *Journal Institute of Metals,* Vol. 53, Mar. 1933, pages 33-37. See *Metals & Alloys,* Vol. 5, Jan. 1934, page MA 4. Ha (13) 9

Electrochemical Corrosion Protection and Corrosion Measurement (Elektrochemischer Korrosionsschutz und Korrosionsmessung) TÖDT. *Die Wärme.* Vol. 56, Nov. 25, 1933, pages 767-769. Electrochemical corrosion protection can be accomplished by an imposed electric current, by galvanic coatings or oxide layers electrochemically effective. Practically the most important corrosion phenomena are of electrochemical nature whereby depolarization by atmospheric O plays a dominating role. Corrosion measurements usually employed are (1) accelerated and (2) long time tests, (3) laboratory and (4) service tests, the advantages and shortcomings of which are discussed critically. Corrosion tests in *stationary* and *running* H_2O:

Mild steel	100	154
Wrought iron	113	169	10
Cast iron	111	272

According to other sources the corrosion of these 3 materials is 1 : 1.3 : 4.3 (water) and 1 : 2 : 100 (H_2SO_4). The C content in cast Fe is responsible for its greater corrodibility. C acts as a local element cathode the more pronounced the greater the chances for cathodic H-ion discharge. EF (13)

APPLICATIONS OF METALS & ALLOYS (14)

Ferrous (14b)

M. GENSAMER, SECTION EDITOR

Hard Steel Pivots and Bearings. Precision Scales Require Advanced Metallurgy. W. J. BURR. *Metal Progress,* Vol. 23, Feb. 1933, pages 36-40. Metallurgy of the pivots and bearings used in scales, some of which are pictured, is given 1% C, cold drawn, steel is used wherever practical. Some parts, due to shape, are made of carburized and hardened low C medium Mn steel. Decarburized skin and scale are removed before heat treating, which is done in small batch type, salt bath or box furnace. Small parts are hardened in the salt bath, larger parts in the box furnace. Quenching of small sizes is done at 1380° to 1400° F., larger sizes at 1420°. Bearings are drawn at 325° F., pivots at 375° F. for extra resistance to chipping. Hardness is C-62 to 64 for bearings and C-60 min. for pivots. Tests on a stress machine for pivots and bearings are described. A given loading upsets the edges nearly in proportion to hardness. Oscillation up to 2° or 3° had little effect on wear of the edges. Over 4° the wear was rapid, also where hardness was less than C-58. 1% C steel performed well in this test, but carburized and hardened steel had more tendency to chip under wide oscillation. Alloy carburizing grades performed well in this respect. Stainless steel tested the same as plain C at comparable hardness. W carbide, tried in small sizes, retained a perfect edge. Welded-on non-ferrous alloys and nitrided pivots chipped under heavy loads. Nitrided pivots are suitable for light loads if of the high speed or special alloy type. The construction of scales with recent improvements in heat treatment and use of corrosion resistant metals is recounted. WLC (14b)

Production of Wear-Resistant Rails. (Die Herstellung von verschleissfesten Schienen.) ERICH BECKER. *Technische Blätter der deutschen Bergwerkszeitung,* Vol. 23, June 11, 1933, pages 328-329. Discussion of various methods of processing wear-resistant rails, as special heat treating methods, use of compound steel for manufacture of which new patented casting methods are described, arrangement of hard steel plates on the rail heads, use of alloy steels. GN (14b)

Wrought Iron Boilers for Hot Water or Low Pressure Steam Generation. (Schmiedeeiserne Heizkessel für Warmwasser- bzw. Niederdruckdampfbereitung.) E. BOLTINER. *Zeitschrift für Schweisstechnik,* Vol. 23, Apr. 1933, pages 101-105. Illustrated description of a boiler made up of 3 units assembled by fusion welding. RRS (14b)

Ocean-Going Seatrain Vessels Carry Mile of Loaded Freight Cars. *Steel,* Vol. 90, Nov. 7, 1932, pages 23-25. Descriptions of Sister ships, Seatrain New York and Seatrain Havana, built by Sun Shipbuilding & Dry Dock Co., Chester, Pa., for Seatrain Lines, Inc., New York. These all-steel ships are equipped to carry 100 loaded freight cars on standard rails, the cars being lifted bodily on and off the ships by huge electric cranes. Considerable savings are effected in loading and unloading time; 100 cars being unloaded and 100 loaded in approximately 10 hrs. Other savings are in labor costs, harbor costs and terminal expense. JN (14b)

"Conte di Savoia." *Marine Engineer & Motorship Builder,* Vol. 56, Feb. 1933, pages 41-46. In construction of hull certain parts have been made of special high-tensile steel of ultimate strength 52-60 kg./mm.^{2} and of 20% elongation. Approximately 5,000 tons of this steel have been used in the form of plates, effecting a reduction in the weight of the upper works of the vessel. Electric welding has been used in the hull construction for the foundations of the auxiliary machinery. Kz (14b)

The Latest British Submarine. *Marine Engineering & Shipping Age,* Vol. 38, Apr. 1933, pages 126-127. Description of engines of vessel. For lightness, steel is employed very considerably in construction of the machinery. Cast steel is used for the bedplate, and the entablature, which is supported by cast-steel columns. Cylinder liners are of cast steel and the pistons of Al, while the cylinder jackets are of steel. Kz (14b)

Nickel Cast Iron in Diesel Engines. *Marine Engineering & Shipping Age,* Vol. 37, Sept. 1932, pages 391-392. Present widespread use of Ni cast iron in Diesel engine construction is ascribed to (1) strength at elevated temperatures, (2) elimination of porosity, (3) maximum resistance to wear, (4) minimum growth due to repeated heating. These properties are discussed at length under the special conditions prevailing in Diesel engines. EF (14b)

Cast Iron for Diesel Engines. *Mechanical World & Engineering Record,* Vol. 92, Nov. 4, 1932, pages 440-442. Among the special cast irons developed for use in Diesel engines, those consisting of an addition of Ni to a suitable cast-iron base are of 3 classes. (1) Small additions refine grain, increase strength, and improve resistance to wear and heat. (2) Higher additions give very hard gray castings, while (3) high additions of Ni give a marked degree of corrosion resistance and useful expansion and other physical properties. The different percentages of Ni added to castings for cylinder liners, cylinder heads and breach ends, pistons, piston rings, and exhaust manifolds are dealt with besides the cast-iron bases which are used. Kz (14b)

Alloys for Chemical Plant Construction. *Mechanical World & Engineering Record,* Vol. 92, Sept. 30, 1932, pages 312-314. Si-Fe and Cr-Ni-Fe alloys are 2 of the recently developed alloys for use in plant handling corrosive liquids. The corrosion resistance of the Si-Fe alloys increases with the proportion of Si. Stainless irons will resist HNO_3 and similar oxidizing agents, and S and some S compounds. They will not resist HCl or H_2SO_4 except under special conditions. The article discusses the application of Si-Fe alloy for machine construction and gives chemical and physical properties of several stainless-irons. Kz (14b)

The Use of Cast Iron for Highly Stressed Machine Components. *Machinery,* London, Vol. 41, Jan. 26, 1933, page 490. **Cast Camshafts Replace Forgings.** *Machinery,* London, Vol. 41, Jan. 26, 1933, page 494. Both articles refer to the adoption of electric furnace alloy iron castings having physical properties comparable to those of forgings at much lower costs. Advantages and methods of production are mentioned and chemical analysis and physical properties are given. Fatigue tests showed a remarkable superiority of cast iron crankshafts over those made of steel Kz (14b)

Breaking the Ice. *Marine Engineering & Shipping Age,* Vol. 38, Mar. 1933, page 90. Propeller blades for ice breakers used by the Canadian Government are made of a cast steel containing 3% Ni. Since the propellers actually hit the ice, they must stand up with little wear and no breakage. Kz (14b)

Porcelain Enamel and Steel Utilized in New Type of Building Construction. *Steel,* Vol. 91, Aug. 1, 1932, page 26. Description of steel constructed gasoline filling station in Chicago, using porcelain enamel metal sections for exterior finish. JN (14b)

Large Uses of Steel in Small Ways. 223rd Article. Household Electric Refrigerators. *Steel,* Vol. 91, Aug. 8, 1932, page 32. Over 965,000 household electric refrigerators were sold in 1931, representing a consumption of 112,500 tons of steel. During the last 10 years, 431,900 tons of steel were used in the manufacture of 3,950,000 all-steel refrigerator units. Their use is increasing steadily. All seams are welded. Construction methods utilize electric spot welding, automatic arc welding, atomic hydrogen welding, and copper hydrogen brazing. JN (14b)

Frameless Steel House Points Way to Lower Cost Construction. *Steel,* Vol. 91, Aug. 29, 1932, pages 21-23, 26. Description of new frameless steel house nearing completion near Cleveland, O., under sponsorship of Insulated Steel, Inc., and American Rolling Mill Co. The various units are largely factory produced, thereby eliminating waste, cutting and fitting. This presents a decided advance toward factory production of low-cost homes. JN (14b)

Cylinder Irons. J. E. HURST. *Automobile Engineer,* Vol. 23, July 1933, pages 245-247. The cylinder barrel portions of 3 cast-iron cylinder blocks were tested in accordance with the requirements of the B. S. I. specification for aircraft material 4K6. This calls for an annular ring form of specimen. This specification gives form and proportions of the annular ring form specimens together
1 with directions for their use in the determination of their breaking strength and modulus of elasticity, designated respectively tensile strength and EN value. This information is not given in this article. Stabilization consisted of slow cooling after being maintained at 500°C. for a time. The stabilizing treatment appears to reduce internal stress which may be expected to have some bearing on the distortion of the cylinder blocks. RHP (14b)

New Studebakers All Have All-Steel Bodies. JOSEPH GESCHELIN. *Automotive Industries,* Vol. 69, Oct. 7, 1933, pages 422-424. All-steel bodies of new Studebaker have been made possible by the use of interchangeable dies. DTR (14b)

Effect of Sulphur Dioxide Gas on Alloys. G. H. MCGREGOR & J. W. STEVENS. *Paper Trade Journal,* Vol. 97, Nov. 2, 1933, pages 40-41.
2 Cr-Ni steels are being used extensively in the fabrication of materials of construction for use in the manufacture of acid and alkaline pulps. Effects of SO_2 gas were studied on Cr-Ni steels and compared with the behavior of brass, bronze, cast iron, and soft steel under the same exposure conditions. Small samples 3"x4"x$\frac{1}{16}$"-¼" thick were exposed to gas containing 17-18% SO_2, 1-2% O_2 and traces of SO_3 at 200-220°C. for 30 day intervals. Test was conducted for 10 months. Losses were calculated in g./in.^{2} Results are tabulated. Cr-Ni steels of the 18-8 and 23-11 types are quite resistant to the corrosive SO_2 gas formed in the pond type coolers. High Cr high Ni alloys are also resistant but toughness and cost preclude their general use. Cr-Ni alloys of the 18-8 type appear to be somewhat more resistant than bronze which is the standard metal for digestor fittings. Cr-Ni alloys are much more resistant than the various types of cast iron or soft steel. CBJ (14b)

3 **Steel for Tractors—Selection and Heat Treatment.** G. C. RIEGEL. *Steel,* Vol. 92, June 26, 1933, pages 28-29. Abstract of paper read before the Tri-City Chapter, American Society for Steel Treating. See "Material Selection in Caterpillar Plants," *Metals & Alloys,* Vol. 4, Nov. 1933, page MA 353. MS (14b)

Developments in the Nickel Industry During 1933. A. C. STURNAY. *Metal Industry,* London, Vol. 44, Jan. 12, 1934, pages 46-48. Revue of industrial conditions; use of Ni in coinage, Ni alloys (Inconel, Monel metal) and as addition to cast iron is briefly discussed. Ha (14b)

Selecting Correct Alloys for Specific Uses. ALBERT G. ZIMA. *Machine Design,* Vol. 5, Sept. 1933, pages 28-31, 60. Most important physical
4 properties are given on (1) low C, 2% Ni steel; (2) medium C, 2% Ni steel; (3) pearlitic Ni-Mn steel; (4) Ni-Cr steel; (5) Ni-V steel; (6) Ni-Mo and Ni-Cr-Mo steel; (7) abrasion resistant steel; (8) austenitic Ni-Mn steel; (9) steel castings for elevated temperatures. The chemical analyses of the various Ni steels of group (1)-(9) are tabulated, the requirements intended to be met with by these steels and the typical applications are listed and 16 references appended. WH (14b)

Use of Mild Steel having a High Elastic Limit in Building Construction (L'impiego dell'acciaio dolce ad elevato limite elastico nelle costruzioni edelizie) G. SIROVICH. *La Metallurgia Italiana,* Vol. 25, Dec. 1933, pages 878-888. The development of mild steels having high elastic limits is reviewed, and the compositions of varieties used in different countries are given; i.e., structural
5 Silicon steel, Krupp steel, Cromador, etc. These steels are used in building construction because their strength and high elastic limit permit a saving of material up to 30%. They are well adapted to fusion or oxy-acetylene welding, at a further saving in weight and material. AWC (14b)

Ferrocart, A Novel Magnetic Material (Ferrocart, der neue magnetische Werkstoff) ALFRED SCHNEIDER. *Die Umschau in Wissenschaft und Technik,* Vol. 37, July 29, 1933, pages 600-602. Aim was to find a material which conducts the magnetic flux but not electric currents. Ferrocart consists of a fine magnetic powder embedded in solid insulation material. The occurrence of eddy currents is eliminated. The new magnetic (synthetic) material is bound to revolutionize radio technique. WH (14b)

6 **Novelties in Mine Casing (Ausbautechnische Neuerungen)** *Technische Blätter der deutschen Bergwerkszeitung,* Vol. 23, Dec. 31, 1933, pages 725-726. Discussion of recent progress in the application of steel in mine casing. There are discussed (1) new rolled shapes, (2) new methods of applying plate steels (3) new steel stemples as those by Schwarz, Toussaint-Heintzmann, Voss. GN (14b)

World's Fair Exhibits To Project Use of Steel in Future Houses. *Steel,* Vol. 92, Apr. 3, 1933, pages 21-23. Brief descriptions of steel houses to be exhibited at A Century of Progress Exposition. MS (14b)

Nonstandardized House Holds Greatest Future for Steel. *Steel,* Vol. 93, Aug. 21, 1933, page 16. **Design Factors Favorable to Steel Frame Residences.** *Steel,* Vol. 93, Aug. 28, 1933, pages 36, 38. Abstracts of "Steel Framing for
7 Small Residences," a 56-page booklet published by the United States Steel Corp. Presents the results of a survey made by a trade research committee drawn from subsidiary companies for the purpose of investigating the demand for steel in residence construction. Indicates that the policy followed in tier buildings is revived with suitable modifications to meet the particular needs of the small residence. Provides architects, builders, and fabricators with convenient information on safe, practical, and economic use of steel. MS (14b)

Alloy Steel Supplies Strength in 60 Speediest All-Metal Transports. *Steel,* Vol. 93, July 10, 1933, pages 23-25. Deals with use of steel for various parts of airplanes being built by Boeing Airplane Co. Steels used are S.A.E. 1025, 2330, and 4130, and KA2ST stainless steel and are purchased according to U. S. Army Air Corps specifications. Lists the minimum physical properties of the S.A.E.
8 steels as received. MS (14b)

Prefabricated Sections Used in New Steel Residence. *Steel,* Vol. 93, July 24, 1933, pages 26-27. Wheeling Corrugated Co. has designed a house in which prefabricated floor and wall sections are used. Connections will be arc welded. Outside surface will consist of porcelain enameled steel sections. MS (14b)

Air Conditioning, 100,000-Ton Steel Market, a Recovery Aid. *Steel,* Vol. 92, May 15, 1933, pages 13-14, 54. Air conditioning will provide a market for a substantial tonnage of finished steel, chiefly sheets. Higher tensile strength with less weight and greater resistance to corrosion will probably be required. MS (14b)

Cap of Peary Monument Made of 18-8 Steel To Withstand Arctic Exposure. *Steel,* Vol. 92, June 5, 1933, page 34. Memorial on Cape York in northern Greenland is capped with a pyramid-shaped hood, electrically welded, ground, and
9 polished. Ship bearing expedition to erect monument used Cr-Ni steel in connection with the engine exhaust stack. MS (14b)

Stainless Steel Used Widely in Modern Bar Designs. *Steel,* Vol. 92, Apr. 3, 1933, page 24. Brief description of bar for dispensing beer in which stainless steel is used for serviceability and decorative effect. MS (14b)

Steel in the Petroleum Industry (Stahl in der Mineralölindustrie) *Montanistische Rundschau,* Vol. 26, Jan. 16, 1934, pages 3-4. For casings in deep-well drilling a steel with 0.3% C and 1.4-1.5% Mn is used, with a small addition of copper for very corrosive soils. Another type of steel used for this purpose contains 0.5% Cr, 0.8% Si, 1.3% Mn, and 0.3-0.4% C. Special nickel steels are used for drill chains, and for the bit is used a heat treated cast steel with 1.25% Ni
10 and 0.6% Cr, faced with stellite or some other hard alloy. For fittings and parts exposed to high temperature in the refining process is used an alloy with 2.5% Ni, 0.8% Cr, and 0.35% C. The process of casting these steels has been perfected to the point where a very smooth casting is produced. A certain percentage of selenium added to special steels of this type improves their machining properties without affecting the tensile strength adversely as was the case with sulphur which formerly was used for this purpose. BHS (14b)

Material for Nitriding Boxes. (Über die Zusammensetzung von Nitrierbehältern.) *Die Metallbörse,* Vol. 22, Sept. 24, 1932, page 1231. Note rejects 18/8 for nitriding furnace material due to the catalysing effect of the nitrides in 18/8 upon the furnace atmosphere. Better results are secured with alloys high in Ni as for instance with 62 Ni, 12.5 Cr, balance Fe or with 67 Ni, 28 Cr, balance Fe. EF (14b)

Wrought Iron for Tanker Construction. *Marine Engineering & Shipping Age,* Vol. 38, Apr. 1933, page 119. Tankers built during the past 12 years have deteriorated more rapidly than those previously constructed. The use of wrought iron, which also is ideal for welding, is being considered as a possible solution of the problem of tanker corrosion Kz (14b)

Investigations on the Wear of High-Grade Gray Castings and Alloyed Gray Castings with Consideration of the Requirements for Pistons and Cylinders of Combustion Motors (Untersuchungen über den Verschleiss von hochwertigem Grauguss und legiertem Grauguss unter Berücksichtigung der an Kolben und Zylinder von Verbrennungsmotoren gestellten Anforderungen) R. Knittel. *Die Giesserei,* Vol. 20, July 21, 1933, pages 301-310; Aug. 4, 1933, pages 324-329; Aug. 18, 1933, pages 352-355. Cast iron with pearlitic structure is particularly resistant to wear (abrasion); this was tested by means of a specially developed method by which cylindrical rods of 10 mm. diameter and 50 mm. length and pieces of about 50 mm. length, 30 mm. width and 10 mm. thickness were made out of the material to be tested; the cylindrical pieces were made to rotate on the stationary pieces with variable pressures without lubrication. With this testing outfit the influence of the constituents was investigated. The absolute hardness is only a relative measure for the wear; the determining factor of abrasion is the difference in hardness between moving and stationary parts. The wear is least when the difference = 0. If the moving part is harder than the stationary part the result is better than in the reverse case. The graphite deposition in long, thin veins is favorable for the wear of high-grade cast Fe, but segregation in coarse, thick veins is harmful. Wear increases with increasing Si content. If the material is annealed (900° C. for 3 hrs.) the pearlitic structure disintegrates into ferrite and wear is increased considerably. The hardness of a casting increases with increasing Mn and the wear is slightly reduced. With increasing Mn content the content of pearlite is again increased after annealing. Hardness is also increased with increasing P content; the mechanical properties, however, in particular deflection, are lowered considerably; this is due to the phosphide eutectic which interrupts the cohesion of the metallic mass. P improves abrasion resistance; above 1% P the wear resistance does not increase in the same ratio as from 0.3 to 1% P. Annealing eliminates this improvement of wear resistance by P except at 1.92% P which sample showed good properties after annealing. Ni increases hardness, but has no influence on the wear; annealing removes this improvement. Cr hardens the basic mass and gives a finer structure; deflection and bending strength are lowered at more than 0.4% Cr on account of carbide formation. Beginning from 0.4% Cr wear resistance is increased and reaches with 0.7% Cr an increase of 25%. More than 0.7% Cr is not advisable on account of difficult machinability. The influence of annealing is eliminated from 0.4% Cr upwards; after 3 hrs. annealing at 900°C. the structure with 0.7% Cr is still unchanged. Cr is therefore advisable for cast iron parts gliding on each other at high temperatures; as little as 0.2% Cr has a marked favorable effect. Cr-Ni increases hardness very considerably, tensile properties are not improved noticeably. The effects of Cr and Ni are noticeable almost in additive proportion; that is, the action of the one is supported or counteracted by the other in the ratio of their weight percentages. The influence of annealing is eliminated at 1.3% Cr-Ni, corresponding to 0.35% Cr. With 1.79% Cr-Ni the wear before and after annealing is the same. Up to 250°C. no change of wear could be stated, except in samples with high P content where a decrease of 25% was found. The quality of the surface is also important; the better the quality of a gray iron the more careful must be the surface treatment; grinding, lapping or honing by machine should be applied. Some practical conclusions are drawn for treatment of machine parts, as pistons, cylinders, etc. 34 references. Ha (14b)

Developments in the Use of Steel in Floor Constructions. Donovan H. Lee. *Structural Engineer,* Vol. 11, Nov. 1933, pages 460-462. Discussion: Wm. G. Shipwright, Vol. 12, Jan. 1934, page 40. Calls attention to the 3 types of fire resistant steel floors developed in the U. S. Properties of German and American light pressed and light rolled steel joists respectively are tabulated. Author sees great possibilities of arc welded open truss joists. Electric and particularly semi-automatic spot welding seems likely to be one of the main means of facilitating the economical production of light built-up steel beams. WH (14b)

The Flexible Shaft in Machine Design. Geo. T. Latimer. *Modern Machine Shop,* Vol. 6, Mar. 1934, pages 26-38. Manufacture of flexible shafts by winding layers of wire of alternating pitch around a center wire is explained and its use, particularly for transmitting small forces, in dentistry, drive of small motors and tools, etc., described. Ha (14b)

Steels in Marine Engineering Service. T. H. Burnham. *Metallurgia,* Vol. 9, Jan. 1934, pages 81-83; *Iron & Coal Trades Review,* Vol. 128, Jan. 12, 1934, pages 52-53. The requirements of steels used for steam and oil-engine propulsion are considered and compared with those in U. S. A. and Germany. Welded joints in drums have been found to be fully satisfactory; steels used by the Admiralty are Types D and D1 with approximately 0.30-0.33% C, 1.0-1.2% Mn and less than 0.2% Si. Results obtained along and at right angles to direction of rolling in D steel were: 17 tons/sq. in. elastic limit, 24 tons yield point, maximum strength 40.8 tons, 28% elongation, 62% reduction of area, 22.2 tons bending fatigue and 49.3 ft.lbs. Izod; the respective values in the transverse direction are 17-24-41.2-21-55.7-20.4-35.1. Flange bolts are made of Cr-Mo steel with 0.3% Cr, 0.5% Mo, or Ni-Cr-Mo steel with 2.5% Ni, 0.5% Cr and 0.5% Mo; the latter hardened and tempered has a yield point of 62 tons/sq. in. and a maximum stress of 72 tons. Steam valves are of Cr-Mo steel, 0.3% C, 1-1.5% Cr, 0.8% Mo, which has a high resistance to creep. Spindles and seats are of a high Ni-Cu-Sn alloy, also of non-corroding steels (12-18% Cr or 18/8 Cr-Ni); also 35% Ni, 12% Cr steel is used. Turbine and equipment material is discussed. Ha + JLG (14b)

Widened Bascule Bridge Has Decking of Steel Mesh. Robert C. Hill. *Steel,* Vol. 92, May 22, 1933, pages 26, 28. In the widening of the University Bridge, Seattle, Wash., the problem of not exceeding the weight limits imposed by the existing counterbalances and operating machinery was solved by the use of riveted steel mesh decking laid over 6" channel supports, weighing altogether 22½ lbs./ft.^{2} This replaced a treated wood-block flooring weighing 40 lbs./ft.^{2} MS (14b)

Drill Steels for Mining Purposes. W. H. Hatfield. *Bulletin Institution of Mining & Metallurgy,* No. 348, Sept. 1933, pages 5-7. See *Metals & Alloys,* Vol. 5, Feb. 1934, page MA 65. AHE (14b)

Metallurgical Questions in Automobile Construction (Questions métalluruiques actuelles en Construction automobile) L. Guillet. *Usine,* Vol. 43, Jan. 4, 1934. Cast irons, steels and alloyed steels at present employed in automobile manufacture are reviewed. Ha (14b)

Puddled Wrought Iron for Gasholder Construction. G. M. Gill. *Gas World,* Vol. 99, Aug. 5, 1933, pages 128-129. There is difficulty in obtaining wrought iron sheets and plates for gasholder construction because it ceased to be manufactured about 10 years ago. Steel cannot be replaced in holder tanks or for the bar sections of holders but for the cups and dips it is possible that wrought iron would be preferable except that the strength and resistance to corrosion should be taken into consideration. Hence, in some cases its use might be confined to the side sheets and the crown. Experience has shown that wrought iron holders last twice as long as the steel holders built in the past century. The author gives some specifications for the quality of the material required. MAB (14b)

Shipbuilding and Steel Trades. *Engineering,* Vol. 136, Dec. 29, 1933, page 716. Editorial commenting on the recent increase in the use of British steel for constructing new ships. The shipbuilding trade in which steel is largely replacing wood is picking up; more orders were taken in the 6 weeks preceding Dec. 16th than in the whole of 1932. LFM (14b)

The Use of Seamless Steel Tubes for Supply Pipe Lines. *Engineering,* Vol. 136, Nov. 17, 1933, page 559. Comments on increasing use of seamless steel tubes for lengthy pipe lines, especially in America. The steel used for these pipes contains 0.3% C and 1.5% Mn and has an average tensile strength of 85,000 lb./in.^{2}. LFM (14b)

Isteg Steel. *Engineer,* Vol. 156, Dec. 29, 1933, page 652. Short description of reinforcing steel developed by Isteg Steel Products, London, and tested by R. Harry Stanger of the Testing Works and Chemical Laboratories, London. Beams reinforced with ordinary bars had 58% more reinforcement than the beams with Isteg bars, yet the Isteg beam stood the same load and gave an average stress of 70,000 lb./in.^{2} for the Isteg bars. Isteg steel is prepared by fixing a pair of bars between two headstocks and twisting them together cold. During the twisting the ends are prevented from approaching each other, so that the steel is subjected to both tensional and torsional strains. LFM (14b)

Diesel Engine Cylinders. *Automobile Engineer,* Vol. 23, Sept. 1933, page 346. Ni cast irons containing from 1% to 2% Ni are the most useful for cylinders. Combined C is in a fine pearlitic state, the graphite tends to split up in the dendritic form. If Ni content is increased the pearlitic structure becomes sorbitic and then martensitic in which stage machining is difficult. When Ni is added the Si content must be lowered. Iron is made in the cupola at the highest possible temperature. Ni is placed in the bottom of the ladle and the metal at almost white heat is tapped into this the Ni readily dissolving at this temperature. Most consistent grain structure is obtained by heat treating slowly. Ni cylinders are much used at present. V and Mo alloys are good but cost is high. RHP (14b)

Crankshafts. *Automobile Engineer,* Vol. 23, June 1933, page 221. A brief consideration of the influence of Mo. The first use of Mo with Ni-Cr steels in crankshafts was shortly after the World War. Mo is now added in the form of a Ca-salt. Percentage of Mo in crankshafts ranges from 0.4 to 0.7%. Steering knuckles and axles as well as crankshafts are often made of alloys containing Mo. RHP (14b)

Tests of Alloy and Heat Treated Carbon Steel Rails. *Proceedings American Railway Engineering Association,* Vol. 33, 1932, pages 573-576. Appendix G to the report of Committee IV on Rails. Statistics are given relating to the purchases of intermediate manganese rail and to failures from various causes in service. A proof-testing device for heat-treated rails consists of three rollers which stress the rail nearly to the elastic limit. No rail which has passed this test without fracture has failed in service. JCC (14b)

Use of Special Alloy and Heat-Treated Irons in Clay Products Plants. W. H. Moriarty. *Brick & Clay Record,* Vol. 84, Jan. 1934, page 30. Use of wear resisting iron for elevator buckets and screen plates is discussed. This material known as Mallix is similar to malleable iron but is stronger, stiffer, and harder. CBJ (14b)

Stainless Steel Overcomes Erosion Problem. J. Kantor. *Machine Design,* Vol. 5, Oct. 1933, pages 29-30. Discusses the selection of materials which stand up against the erosive action of carbonated water. Bronze carbonators were heavy, cumbersome, expensive and less immune than pure Sn utilized as lining $\frac{1}{16}$" thick applied to cast iron. Invisible pin holes lead to punctures and electrolysis. Complete remedy was assured by utilization of stainless steel. Fittings, formerly cast brass and tin plated by the hot process, are now brass forged and electrotinned. The agitator, which formerly was die cast from pure Sn, now is stamped from polished stainless steel sheet. Agitator shaft and bearing housing are now also made of 18-8. Increased life was secured by Al bronze worm wheels instead of P bronze. Glass linings have been experimented with. WH (14b)

GENERAL (15)

RICHARD RIMBACH, SECTION EDITOR

Metallurgy and Thermo-Chemistry. (Metallurgie und Thermochemie.) W. A. Roth. *Die Metallbörse*, Vol. 22, Oct. 1, 1932, pages 1261-1262. Points out the paramount role which thermo-chemistry plays in metallurgical processes and historically reviews the contributions of Thomsen, and Berthelot. After oxidation effects of metals have been measured at ordinary temperatures and the values being adjusted to say blast furnace temperatures with the aid of the Kirchhoff formula, the examination of the metal oxide by X-rays is urged. When determining the heat effect of the Si oxidation, X-rays disclosed the presence of cristobalit instead of quartz. Roth fully considers the 3 methods for securing thermo-chemical data: (a) Reduction of metals at elevated temperatures. (b) Oxidation of metals in the Berthelot calorimeter. The writer's and co-workers' determination of data in the thermo-chemical field of Fe (Fe, FeO, Fe_3O_4, Fe_2O_3, Fe_3C) through the agency of paraffin as auxiliary substance are considered and the combustion heat and re-determinations of metallurgically important gases (CO, H_2, CH_4) by Rossini and Banse-Roth are discussed. (c) Dissolution of metals, oxides, carbonates, slags, etc., in acids in the calorimeter involves many difficulties. The lack of data covering the Bessemer process is pointed out. EF (15)

Light-Weight High-Pressure Gas Cylinders. Frank S. Marsh. *Engineering*, Vol. 134, Oct. 21, 1932, pages 489-490. Condensed from paper read before the Iron & Steel Institute, Sept. 1932. See *Metals & Alloys*, Vol. 4, June 1933, page MA 177. LFM (15)

Statistical Research in Metallurgy. Hans Diergarten. *Metal Progress*, Vol. 24, Aug. 1933, pages 46, 60. The writer comments on the usefulness of statistical methods in the elimination of various types of trouble in metallurgical operations. WLC (15)

Recent Developments in Metallurgy. C. H. Desch. *Iron & Coal Trades Review*, Vol. 126, May 19, 1933, page 785. The phenomena of aging and age-hardening have found greatest attention in recent metallurgical progress; materials have been developed which show this tendency to a very limited degree by eliminating elements which were recognized to be the reason, as for instance the presence of N in mild steel. The precipitation theory explaining the facts, and interpretation of X-ray examinations are discussed briefly. Ha (15)

The Development of Modern Steels. *Electric Railway, Bus & Tram Journal*, Vol. 67, Oct. 14, 1932, pages 186-187. A review of the nitriding process, the high-frequency electric crucible steel-making furnace and its successful application to the melting of high-cobalt steel for the largest permanent magnet made for the research on β-ray spectroscopy in the Cavendish Laboratory, Cambridge, the development of high-speed tools welded onto an ordinary steel shank instead of the more expensive tungsten carbide tipped tools, the manufacture of a Ni-Cr-Mo steel with low amounts of Mn and Al invented for axles and crankshafts of the following physical properties: 60-70 tons/in.^{2} tensile strength, 55-60 tons/in.^{2} yield point, 15-20% elongation, 50-60% reduction of area, 40-50 ft. lbs. Izod impact. Attention is furthermore directed to a case-hardening 5% Ni steel (gears, gear shafts) and to a Cr-Mo steel as structural material yielding 95,000 lbs./in.^{2} tensile strength, 60,000 lbs./in.^{2} yield point and 12% elongation. The remarkably increased output of Co steels (and W and Cr steels) for permanent magnets is emphasized. WH (15)

Estimating Metal Stocks. *Foundry Trade Journal*, Vol. 48, June 1, 1933, page 378. A brief article emphasizing the need (in order to prevent waste) for preparing periodic, accurate stock records in raw material warehouses, and for more frequent visual estimates of weights in stock. OWE (15)

Journal of the Institute of Metals. Vol. LI. Proceedings. Edited by G. Shaw Scott. Institute of Metals, London, 1933. Cloth, 5½ x 8½ inches, 363 pages. Price 31s. 6d. While the individual articles to be presented at the meetings of the British Institute are now printed, along with non-ferrous abstracts, in the monthly issues of the Journal, the discussion is only available in the semi-annual bound volumes. This volume contains illuminating discussion on the articles on Se-coating of elektron alloys, patina on Cu, wear in polishing of plated surfaces, Al-Cu alloys, Al-Ag alloys, conversion of atomic and weight percentages in ternary systems, Cu-Ni-Al precipitation hardening, porosity in Al and Cu, annealing of Cu, and effect of Al and Ni on alpha brass. H. W. Gillett (15)-B-

Proceedings American Society for Testing Materials, Vol. 33, 1933. Published by the Society, Philadelphia. Paper, 6 x 9 inches, **Part I, Committee Reports and Tentative Standards,** 1092 pages, **Part II, Technical Papers,** 804 pages.

The volumes contain a very large amount of valuable metallurgical information. Part I contains tentative specifications on steel for bridges, buildings, plates, pressure vessels, on carbon steel castings, alloy steel forgings, elliptical springs, pipe for high temperature service, hot dip galvanized hardware, wrought iron rivets, aluminum alloy ingot, sand castings, shapes and sheet, and on aluminum and zinc base die castings. Methods of chemical analyses for Mg alloys, for P in Cu alloys and for electrical resistor alloys are given.

Methods for compression, Rockwell hardness, impact, short-time high-temperature tensile tests, and long-time high-temperature creep tests are set forth. A very comprehensive and useful report on impact testing of cast iron, containing much of interest on cast iron beside the impact data, and reports on atmospheric and other corrosion tests on non-ferrous metals and alloys, and on metallic coatings, as well as a discussion of methods of corrosion testing of stainless steels are included. A cooperative investigation on short-time high-temperature tensile tests of a .28 C steel and discussion of the significance of that test, and comment on the proportional limit and breaking strength in high temperature work, are presented.

Of metallurgical as well as general interest is the "manual on presentation of data," which discusses the application of statistical methods.

Part II contains Dr. Gough's lecture on crystal structure and fatigue and the Symposium on Cast Iron, both of which are very complete and valuable, and on which we have previously made editorial comment.

Among other outstanding articles is one on fatigue of light metals and alloys, with a description of a wide variety of testing machines and an appraisal of the futility of short fatigue tests on such alloys. Curves are shown for two alloys each of which runs 10 million cycles at 23,000 lbs./in.^{2}, but when the tests are carried to 400 million cycles, the respective stresses are 22,000 and 15,000 lbs./in.^{2}.

Another deals with a torsion impact test which shows a remarkable peak in toughness of a carbon tool steel after tempering at 350° F.

The effect of corrosion on structural aluminum alloy shapes is found to be far less damaging than it is on very thin sheet. In discussion it was brought out that the bursting strength of steel tubes pitted by corrosion was not really reduced by the pits.

Other articles deal with shear and Poisson's ratio in steel, a tentatively proposed accelerated endurance test, a type of high temperature test for exploratory purposes preliminary to creep tests, data on endurance of galvanized wire under pulsating tensile strength, on corrosion of iron, on a Cd Ni bearing metal, on effect of Pb in Sn-base babbitt, and on effect of S and Fe in cast red brass.

An article on collection of standardization data fits in with the discussion of statistical methods in Part I.

The metallurgist who does not have access to these volumes is missing a great deal of important information. H. W. Gillett (15)-B-

Metallurgy of Iron and Steel. Bradley Stoughton. McGraw-Hill Book Company, New York, 1934. Cloth 6 x 9¼ inches, 559 pages. Price $4.00.

The first edition of this standard text book appeared in 1908, the third in 1923. Progress in knowledge and practice has advanced so much in the last decade that it has been necessary to rewrite the book, not merely to revise it. Some of the earlier chapters, on whose subjects other recent books are available, have been omitted entirely, including those on corrosion and metallography. More space is given to the basic open hearth process, and this crowded out chapters on welding and on testing which had been prepared for inclusion. Heat treatment is discussed, alloy steels briefly dealt with, and hot and cold working discussed at some length, but the reader is expected to consult other texts as well. Each chapter ends with a list of standard publications on that topic.

The appearance and interest of the book are improved by many new illustrations showing modern equipment and practice, though one of a molder setting a core still shows him wearing a derby hat.

The reader will get a good picture of smelting, open hearth and electric melting, an introduction to rolling and forging, to foundry practice and heat-treatment, and some idea of the properties of wrought and cast steel, cast and malleable iron. The book is written more for the student who will become a producer of steel than for the one who will use it.

The publication of a new edition of a book of this kind by a recognized authority allows comparison with the previous edition to select those advances of the past decade which now require mention, even though the author is cramped for space. On this criterion, advances in fundamental knowledge of gas velocity in the blast furnace, of open hearth deoxidation, slags and inclusions, of superheating of cast iron, of solubility of carbon in ferrite, of Widmanstaetten structure, of the nature of martensite and of the effect of gas bubbles in causing soft spots in quenching are noteworthy. Notable progress in commercial practice mentioned by Stoughton include the Aston process, abolition of the 12 hr. shift in the steel mill (with no approval of the now-discussed 6 hr. shift), washing of iron ores, automatic control of reversing valves in both blast furnace and open hearth, the stock line recorder, in the open hearth the use of wider hearths, sloping back walls, insulation and water cooled reversing valves with resultant longer campaigns and a raising of the thermal efficiency from 18 to 24%. Use of silicomanganese in the open hearth, of instrumental control of the Bessemer blow, commercial high-frequency induction melting, the 100 ton electric arc furnace, increased use of big end up ingots, processes for welding steel pipe, for centrifugal casting of iron pipe, the introduction of nitriding, addition of Mo to the list of important alloying elements for steel and cast iron, and the general development of alloy steels and cast irons are also in the list of recent achievements.

Some of the developments not featured, or else so briefly as to be missed by the reviewer in scanning the book, are continuous strip rolling, automatic screw downs, the Steckel mill, knowledge of inclusions, over-reduction, etc., in cast steel, sand control in the foundry, short-cycle malleable, knowledge of precipitation-hardening phenomena, control of aging, of grain size, and information on "normal" and "abnormal" steel, which the author states on p. 443 he will discuss in detail later but which discussion the reader could not find from the index or the text.

The general increase in use of instruments of quantitative measurement for control of processes is covered by some specific instances, but hardly emphasized as much as it might well have been.

The book is rather free from misleading brief allusions to subjects not fully dealt with that are quite common in such text books. A few such cases occur, however, the reviewer doubting if the reader will get a proper conception of creep at high temperatures or a proper appraisal of the importance of austenitic stainless steels from the comments made. Some of the side remarks are interesting, even though brief. Stoughton sees no hope for direct smelting processes that do not produce a metal free from gangue and that can be rolled without remelting. His attitude on inclusions, i.e. "dirty steel" agrees with what Coolidge is alleged to have given as the preacher's attitude in a sermon on "Sin." "He's agin it."
H. W. Gillett (15)-B-

S. A. E. Handbook. 1933 Edition, Society of Automotive Engineers, Inc., New York, 1933. Fabrikoid, 5½x8½ inches, 733 pages. Price to non-members $5.00. The page size of the new edition has been changed, the old page size was 4x7 inches. The S. A. E. handbook includes all current standards and recommended practices adopted by the society. A new group classification of the standards into sections of the handbook has been adopted so that the specifications will be found grouped according to type rather than to the particular kind of automotive apparatus to which they may apply. Richard Rimbach (15)-B-

Report of 71st Meeting, Verein deutscher Ingenieure, 1933 (V. D. I. 71 Hauptversammlung) V. D. I. Verlag, Berlin. Paper, 8¼ x 11¼ inches, 157 pages. Contains, besides articles of engineering interest in several fields, the following of metallurgical interest, though the treatment is primarily that of the engineer user of metals rather than of those concerned with production, fabrication and treatment: Endurance of welded joints, G. Schafer, pages 16-22; Practical measurement of shrinkage stresses in welding, G. Bierett, pages 22-29; Nondestructive magnetic-inductive method for weld-testing, E. Schweitzer and S. Kiesskalt, pages 29-33; Welding of hydronalium, E. J. de Ridder, pages 33-38; Strength of light metals, H. Stendel, pages 73-83, discussion pages 97-98. Discussion is included with each of the other papers also. The last 2 articles relate chiefly to aircraft problems. H. W. Gillett (15)-B-

Review of Science (Die Chronik der Technik, V D I Jahrbuch 1934) Edited by C. Matschoss. V. D. I. Verlag, Berlin, 1934. Paper 5¾ x 8¼ inches, 189 pages. A collection of short correlated abstracts written by specialists in various fields; the literature references used are given.

The following main divisions are made: Applied Sciences; Construction Materials; Fuels; Boilers; Steam Power Stations; Hydraulic Stations; Electricity; Machine Design; Construction; Finishing; Pumps, Compressors, Ventilators; Material Handling; Transportation; Textiles; Light; Glass; Chemical Industry; Dust; Heating and Air Conditioning; Refrigeration, Agriculture; Food; Public Works; Patents.

The section which will particularly interest the metallurgical engineer is that on Construction Materials which covers under ferrous: blast furnace operation, by-product plant, steel plant operation and foundry; under non-ferrous: copper and copper alloys, press castings, aluminum and aluminum alloys. A subdivision of this section covers the testing of ferrous and non-ferrous products. Richard Rimbach (15)-B-

Research Developments in 1933. *Metal Industry*, London, Vol. 44, Jan. 12, 1934, pages 58-60. Research work done in 1933 in Great Britain in the field of Cu and Al alloys, Pb, Ta, Ni, casting and working of metals, corrosion and fatigue, gases in metals, X-rays and radiology, and electrodeposition is reviewed. Ha (15)

Material Testing and Experience (Werkstoffprüfung und Erfahrung) Fr. Koerber. *Zeitschrift Verein deutscher Ingenieure*, Vol. 78, Feb. 10, 1934, pages 195-199. The extreme importance of testing of materials and metallurgical research is pointed out in order to arrive at still further improvement in quality of materials and developing special materials so that safety of structures and economy is increased. The value of the various mechanical tests and correlation of experience in carrying out the tests in proper manner is discussed. 11 references. Ha (15)

The Manufacture of Drill and Other High Grade Steels at Vereeniging, Transvaal. J. H. Dobson, G. Robson, J. Burnard Bullock & H. Clarke. *Journal of Chemical, Metallurgical & Mining Society of South Africa*, Vol. 34, Nov. 1933, pages 166-202. **Steel Manufacture in the Transvaal.** *Iron & Coal Trades Review*, Vol. 128, Feb. 16, 1934, page 296. The wire works of the Union Steel Corp. and the plant processes are described. Ha + AHE (15)

Economic (15a)

Gold in Canada. A. H. A. Robinson. *Canada Department of Mines, Mines Branch* Report No. 734, 1933, 92 pages. General. Largely economic. AHE (15a)

The Steel Industry—What of Its Future? E. L. Shaner. *Steel,* Vol. 92, Jan. 2, 1933, pages 57-61. An appraisal of the future markets for steel. Author feels that the opportunities of the future will be far greater than anything the industry has experienced in the past. MS (15a)

Office and Business Methods in the Modern Foundry. S. Howard Withey. *Iron & Steel Industry & British Foundryman,* Vol. 6, May 1933, pages 277-279. Problems in foundry cost accounting are described. CHL (15a)

Cost Price in the Foundry (Les Prix de Revient en Fonderie) L. Thieaut. *Revue de Fonderie Moderne,* Vol. 27, May 10, 1933, pages 137-142. Factors determining the cost of production in the foundry and overhead expenses and proper means of checking them are discussed. Ha (15a)

Scrap and the Lead Market. Samuel Tzach. *Engineering & Mining Journal,* Vol. 134, Sept. 1933, pages 371-373. An economic discussion. WHB (15a)

Iron and Steel Trade and Industry in Italy. A. E. Turner. *Iron & Coal Trades Review,* Vol. 127, Nov. 10, 1933, page 703. Report of the British Department of Overseas Trade on Italian economic conditions and trade statistics from 1929 to 1932 itemized for steel production. Ha (15a)

Home Supply of Iron Ores to the German Blast Furnace Plants (Die Versorgung der deutschen Hochofenwerke mit einheimischen Eisenerzen) W. Luyken. *Stahl und Eisen,* Vol. 53, Jan. 5, 1933, pages 1-15; *Iron & Coal Trades Review,* Vol. 126, Feb. 17, 1933, pages 253-254. Development of German iron ore production and present status of the different deposits are discussed, necessity of import of foreign ores, labor conditions and outlook for future development analyzed. Ha (15a)

Present State of the World's Iron Industry (Der heutige Stand der Eisenindustrien der Welt) O. Petersen. *Stahl und Eisen,* Vol. 53, July 13, 1933, pages 717-733. **The World's Iron and Steel Industries.** *Iron & Coal Trades Review,* Vol. 127, July 21, 1933, pages 89-90; July 28, 1933, page 138. The iron and steel making capacities of Germany; Poland, Czecho-Slovakia, and Austria; United States; France; Luxemburg and Belgium; England; Russia; Japan; Italy; Spain; and other countries are discussed and illustrated graphically by maps. Data up to 1932 are summarized. Ha + SE (15a)

International Control of Tin Ore. *Tin,* Feb. 1933, pages 1-3. After dealing with world production and consumption and crisis during last 5 years (1927-1932) results of restrictions in tin industry are discussed and views developed for future. A permanent tin-control plan is advocated to prevent both extortion of prices and over-production by more rational and efficient methods of production and at the same time also by conservation of tin resources. Ha (15a)

World Tin Consumption Analysis. *Tin,* Sept. 1933, pages 1-3. Statistical curves show the growing national demand in Europe and U. S. A. Ha (15a)

A Glance at Czechoslovakian Industry (Un Coup d'Oeil sur l'Industrie Tchécoslovaque) *Usine,* Vol. 42, Oct. 26, 1933, page 29. General conditions are discussed; cooperative systems have been developed to a great extent. A few plants, their organization, training of apprentices, and social institutions are described. Ha (15a)

Roumanian Production of Minerals and Metals. *Engineering,* Vol. 136, Aug. 25, 1933, page 190. Summary of facts from a recently-published report by Ioan Arapu and Miss N. Georgescu prepared under the auspices of Uniunea Industriilor Metallurgice si Miniere din Romania. It is in French and English and is entitled: "The Mineral and Metallurgical Production of Roumania, According to Statistics Collected in 1932." LFM (15a)

Iron Ore Resources of the U.S.S.R. *Far Eastern Review,* Vol. 29, July 1933, pages 305-306. Data and discussion on Ural-Kuznetz deposits, Krivoy Rog and Kerch ores, Kursk magnetic anomaly, East Siberia, miscellaneous deposits, growth in output of iron ores. WH (15a)

U. S. Tin in 1932. *Metal Industry,* London, Vol. 43, Sept. 15, 1933, page 241. Statistical data on production, import, export, consumption and price movement for 1932. Principal consumers are the canning and motor vehicle industries. Ha (15a)

Electrochemical and Electrometallurgical Industries in Switzerland (La situation des industries électrochimiques et électrometallurgiques de la Suisse) *Journal du Four Electrique,* Vol. 42, Dec. 1933, pages 427-428. Statistical data covering the state of these industries in Switzerland in 1932. JDG (15a)

Iron Ore Output in 1932. *Iron & Coal Trades Review,* Vol. 127, Sept. 22, 1933, page 445. Statistical data for Great Britain from the Report of the Secretary for Mines. Gives quantity and prices. Ha (15a)

The Iron and Steel Industry in Germany. *Iron & Coal Trades Review,* Vol. 127, Sept. 8, 1933, pages 351-352. A report of the Department of Overseas Trade on conditions in Germany during 1932 and 1933 with particular bearing on the British industry. Ha (15a)

Mineral Output of Great Britain in 1932. *Iron & Coal Trades Review,* Vol. 127, Sept. 8, 1933, page 349. Statistical review issued by the Secretary for Mines. Ha (15a)

World's Output of Pig Iron and Ferro-Alloys. *Iron & Coal Trades Review,* Vol. 127, Dec. 8, 1933, page 864. Statistics for 1931 and 1932 according to countries. Ha (15a)

The Iron Ore Industry in France. *Iron & Coal Trades Review,* Vol. 127, Dec. 15, 1933, page 912. Report on conditions in 1932, statistics of ore output from 1913 to 1932. Ha (15a)

The German United Steelworks Corporation. *Iron & Coal Trades Review,* Vol. 127, Dec. 8, 1933, pages 868-869, 879; Dec. 15, 1933, page 910. Organization, decentralization schemes and statistics of output of the various products in 1932 and 1933 are described. Ha (15a)

Iron Ore Resources of Russia. *Iron & Coal Trades Review,* Vol. 127, Nov. 24, 1933, page 791. Recent geological survey of the U.S.S.R. revealed extremely large and rich ore deposits in the Krivoi Rog district and Kursk region estimated at 200 billion tons. Geological conditions and output of individual mines are given. Ha (15a)

Iron and Steel Trade with India. *Iron & Coal Trades Review,* Vol. 127, Oct. 27, 1933, page 627. Conditions and prospects of British Trade with India are discussed and statistics given of production and trade with Germany, Belgium, and France. Ha (15a)

The German United Steel Works Corporation. *Foundry Trade Journal,* Vol. 49, July 27, 1933, page 48. A brief article which deals with the decentralization scheme involving most of the important German steel companies. OWE (15a)

Mining and Metallurgy in Luxembourg in 1932 (Bergbau und Hüttenwesen Luxemburgs im Jahre 1932) *Glückauf,* Vol. 69, Nov. 11, 1933, pages 1065-1068. Statistical data of mining of ores, coal, import, export, wages and comparative data from 1925-1932. Ha (15a)

Antimony Production in China. *Far Eastern Review,* Vol. 29, Aug. 1933, pages 377-378. China raised its share of the world's Sb production from 50 to 80%. The mining, ore dressing and smelting practice at Hunan, which turns out 90% of China's Sb production are discussed. The following tables are included: (1) Sb production in China, Hunan and the world from 1911-1930, (2) World's production of Sb from 1911-1930 (12 different countries), (3) Sb prices during the period from 1911-1930, (4) American import of Sb from China from 1911-1930, (5) analyses of Hunan Sb brands. WH (15a)

Industrialized Russia. Alcan Hirsch. Chemical Catalog Company, Inc., New York, 1934. Cloth, 5⅝ x 8¼ inches, 310 pages. Price $3.00. The reviewer found Dr. Hirsch's account of such intense interest that after once starting the book he was reluctant to lay it aside until finished. Dr. Hirsch makes the reader feel that he has actually been present with him during the many personal experiences he relates. As Chief Consulting Engineer to the Soviet Chemical Industry, he had opportunities for observation seldom given to many who have written about Russia.

The book was written since the recognition of Soviet Russia by our Country and is therefore up-to-date. Many pertinent facts as to the present status of Russia's basic industries are presented.

The readers of Metals and Alloys will be interested to read that there are five large research institutes wholly confined to metallurgy.

Chap. V devoted to Iron and Steel presents statistics of the industry and progress under the first Five-Year Plan.

One of the incidents related by Dr. Hirsch provides food for serious thought especially if we have followed the recent revelations of dishonesty and incompetence in government.

A Russian "drew a very glowing picture describing how they planned to have a building site eighteen kilometers away from the chemical center. . . . He explained that there would be different levels of culture depending upon the ability and character of the individual. . . . His vision was a very rational and practical one, so much so that an American present remarked, 'Why it would be possible for us to do the same in our country'!"

"The Russian replied—'Oh no, it would be absolutely impossible for you to do this in your country, because your leaders are too dishonest'."

The book is well printed and profusely illustrated. Richard Rimbach (15a)-B-

The Mineral Industry, Its Statistics, Technology and Trade During 1932. Vol. 41. Edited by G. A. Roush. McGraw-Hill Book Company, Inc., New York, 1933. Cloth, 6x9 inches, 680 pages. Price $12.00. Fortunately through the financial cooperation of the American Institute of Mining and Metallurgical Engineers it was possible to publish the present volume. The book is unquestionably of value and it also is desirable to maintain the continuity of such statistical data.

The Mineral Industry is not an original publication, it is a summary of the statistical and technological progress of the year in each of the important branches of the industry, based on the current technical press, and on official and unofficial statistical reports on production, consumption, trade, etc., both domestic and foreign, supplemented by the personal knowledge and experience of the reviewer in charge of each particular subject. Richard Rimbach (15a)-B-

Alloy Steel Will Help Industry to Win New Markets in Future. *Steel,* Vol. 92, Jan. 2, 1933, pages 65-66. Review of the American alloy steel industry for 1932 including tables of the percentage of consumption by groups and by products for 1928-1932 and the percentage of distribution of individual products by consuming groups in 1932. For 1932, the percentages were: Automotive, 77.64; machine-tool, 3.54; oil, 0.82; agricultural, 1.69; construction, 0.68; export, 0.43; railroads, 1.92; ship-building 0.42; and miscellaneous, 12.86. MS (15a)

Mercury Industry in 1932—Advance Summary. H. M. Meyer. *United States Bureau of Mines, Mineral Market Reports* No. M.M.S. 209, June 9, 1933, 1 page. In 1932, the U. S. produced 12,622 flasks of Hg with a calculated value of $731,129, a decrease of 49% in quantity and 66% in value from 1931. California produced 5,172 flasks, 41% of the total and 62% less than in 1931. Oregon produced 2,523 flasks, ½ the amount in 1931. Nevada's output decreased 79% to 474 flasks. Washington declined from 560 to 407 flasks. Production increased in Texas and Arkansas. Imports were 8,114 flasks as compared with 356 in 1931. Exports were 214 flasks, 4,984 in 1931. AHE (15a)

By-product Sulphuric Acid at Copper and Zinc Plants in 1932—Advance Final Summary. H. M. Meyer. *United States Bureau of Mines, Mineral Market Reports* No. M.M.S. 210, June 9, 1933, 1 page. The output of by-product H_2SO_4 at Cu plants in 1932 was 258,994 short tons of 60° acid; Zn plants added 341,340 tons more. At Zn plants, 65,510 tons of S were used to supplement the gases derived from the roasting of Zn blende and 244,644 tons of H_2SO_4 were made therefrom. No S was used at Cu plants. AHE (15a)

Cadmium Industry in 1932—Advance Summary. H. M. Meyer. *United States Bureau of Mines, Mineral Market Reports* No. M.M.S. 216, Aug. 9, 1933, 1 page. Production of Cd in the U. S. in 1932 was 799,501 lbs., as compared with 1,050,529 lbs. in 1931 and 2,777,762 lbs. in 1930, the record year. The Cd content of Cd compounds was 259,800 lbs. There were no imports. AHE (15a)

Motorship Incorporating Welded Hull and Riveted Aluminum Upper Structure ("Mythen." Fahrgastmotorschiff mit geschweisstem Schiffsrumpf und genieteten Aluminiumaufbauten) Lottmann. *Werft, Reederei und Hafen,* Vol. 14, Apr. 1, 1933, pages 91-93. Full description of a 50 ton motorship recently built in Switzerland. The Fe parts of the welded steel hull were Zn sprayed before welding. The upper structure is built up by 5 mm. sheets of Anticorrodal. The savings in weight due to the adoption of welding amounted to 17% with reference to the all-welded hull and to 20% due to the replacement of steel and wood by Al in the upper structure. WH (15a)

A Cost Analysis of Zinc Die Casting vs. Machined Castings. L. H. Morin. *Metal Industry,* N. Y., Vol. 31, Feb. 1933, pages 168-169. The cost analysis of making a drive segment and an operating cam indicated a saving of more than ½ and 1/3 respectively if die cast instead of being machined from castings On a reorder these figures were reduced to 1/6 and ¼. PRK (15a)

Gold, Silver, Copper, Lead and Zinc in Montana in 1931. T. H. Miller. *United States Bureau of Mines, Mineral Resources of the United States, 1931,* Part 1, June 19, 1933, pages 479-509. The output of Au, Ag, Cu, Pb and Zn from Montana in 1931 was valued at $19,575,053, a decrease of 40% from 1930 and 61% less than the average for the decade. Au production was $829,192, a decrease of 8% from 1930 and the lowest output recorded since records were started in 1904. Ag output was 3,829,837 oz. valued at $1,110,653, a decrease of 45% in quantity and 59% in value since 1930. Wyo. produced 184,555,735 lbs. of Cu valued at $16,794,572, a decrease of 6% in quantity and 34% in value from 1930. Pb output was 8,860,186 lbs., a decrease of 58% from 1930, valued at $327,827, 69% less than in 1930. Zn production was 13,494,986 lbs. valued at $512,809, a decrease of 74% in quantity and 80% in value. AHE (15a)

Copper in 1931. C. E. Julihn & H. M. Meyer. *United States Bureau of Mines, Mineral Resources of the United States, 1931,* Part 1, July 11, 1933, pages 575-600. World smelter production of new Cu in 1931 was 1,363,000 metric tons, a decrease of 14% from 1930. Production in the western hemisphere declined 17% and elsewhere only 5%. North America produced 50.5% of the world total (56.1% in 1930, 59.3% in 1929) and declined 22%; South America contributed 19.1% (16.2% in 1930), increasing output almost 2%; Africa declined 8%, but continued to occupy a more important place in the world picture, furnishing 10.3% of the total (9.6% in 1930); Europe showed the same trend, 3% decline, but a gain from 11.8 to 13.2% of the total. Asia and Australia are of minor importance, but declined 3% and 13%, respectively. In North America, Canada increased output 9%, while the United States declined 26% and Mexico 23%. Smelter output from domestic ores was 1,042,711,178 lbs. AHE (15a)

The Copper Smelting Combine of Central Ural (Russia) V. S. Gulin. *Tsvetnuie Metallui,* No. 1, Jan. 1932, pages 73-81. (In Russian.) A description of proposed projects of copper smelters of the Central Ural Copper Combine. The plant is designed to produce 75,000 tons of Cu per year. Large quantities of ore are available containing 1.6% Cu, 40% Fe, also appreciable amount of gold and silver. Some of the ores contain Zn and As. BND (15a)

Gold, Silver, Copper, Lead and Zinc in Utah in 1931. C. N. GERRY & PAUL LUFF. *United States Bureau of Mines, Mineral Resources of the United States, 1931*, Part 1, July 11, 1933, pages 543-574. The output of Au, Ag, Cu, Pb and Zn from Utah mines in 1931 was valued at \$28,970,974, less than any year since 1921 and about 3/5 the total value in 1930. Au output declined 5% to \$4,108,323. Ag production (8,290,966 oz.) decreased about 43% in amount and 52% in value. Cu was off 16% to a total of 151,236,505 lbs. worth \$13,762,522, 41% less than 1930. Pb output declined 31% in quantity to 158,423,453 lbs. and 49% in value to \$5,861,668. Decrease in Zn output was 16% in amount and 34% in value; the production was 74,581,072 lbs. worth \$2,834,081. AHE (15a)

Production of Gold, Silver, Copper, Lead and Zinc in Utah in 1932, by Counties. C. N. GERRY. *United States Bureau of Mines, Mineral Market Reports* No. M.M.S. 225, Aug. 22, 1933, 1 page. Production of Au in Utah in 1932 was 135,256.35 oz. (198,740.12 oz. in 1931), Ag 6,962,097 oz. (8,290,966 oz. in 1931), Cu 64,964,111 lb. (151,236,505 lb. in 1931), Pb 125,552,966 lb. (158,423,453 lb. in 1931), and Zn 59,331,888 lb. (74,581,072 lb. in 1931); the total value was \$14,398,593, 50% of 1931. AHE (15a)

Mine Production of Gold, Silver, Copper, Lead and Zinc in Washington in 1932, by Counties. C. N. GERRY. *United States Bureau of Mines, Mineral Market Reports* No. M.M.S. 226, Aug. 24, 1933, 1 page. Production of Au in Washington in 1932 was 5,082.13 oz. (2,904.19 oz. in 1931), of Ag 17,412 oz. (24,410 oz. in 1931), Cu 5,524 lbs. (202,503 lbs. in 1931), Pb 1,842,267 lbs. (2,771,116 lbs. in 1931), Zn 4,489,334 lbs. (9,947,495 lbs. in 1931); total value \$300,263 (\$565,498 in 1931). AHE (15a)

Developing New Products. J. E. HAYES. *Executive's Service Bulletin*, Metropolitan Life Insurance Co., Vol. 11, Apr. 1933, pages 1-2, 4, 8. The president of The New Jersey Zinc Co. discloses methods of company's Technical Service Group whereby close liaison is maintained between research staff and users of zinc products while touch is kept also with advertising, publicity and sales. MFB (15a)

Gold Production of Small Mines in California, 1932. V. C. HEIKES. *United States Bureau of Mines, Mineral Market Reports* No. M.M.S. 199, May 17, 1933, 1 page. In 1932, 12,000 individuals in California produced and sold \$493,437 worth of new Au in 30,880 lots ranging from 9 cents to \$100 (average \$16). AHE (15a)

Gold, Silver, Copper, Lead and Zinc in Colorado in 1931. C. W. HENDERSON. *United States Bureau of Mines, Mineral Resources of the United States, 1931*, Part 1, July 10, 1933, pages 511-542. The total calculated gross value of recovered and recoverable Au, Ag, Cu, Pb and Zn in ores mined in Colorado in 1931 was \$7,942,154, a decrease of 40% from 1930. Value of Au increased 7% to \$4,822,734, Ag decreased 62% in value (to \$636,815) and about 50% in quantity, Cu decreased 46% in value (to \$743,015) and about 22% in quantity, Pb declined 77% in value (to \$509,416) and 69% in quantity, and Zn fell off 65% in value (to \$1,230,174) and about 55% in quantity. AHE (15a)

Automobiles Take Most Steel in 1932. *Steel*, Vol. 92, Jan. 2, 1933, pages 62-64. Tabulates the ratios of the main groups in the consumption of finished rolled steel in United States for 1922-1932, and the distribution of the various products in percent. and in gross tons to consuming groups for 1932. The latter figures are based on returns from 84 operating companies representing 98.2% of the output for the entire industry. For the first time the container group led the railroads. By percentages, the consumption in 1932 was: automotive, 18.15; buildings, 16.38; containers, 10.79; railroads, 9.09; oil, gas, and water, 5.50; machinery, 3.39; exports, 3.31; and all other, 33.39. MS (15a)

World Output Back to Start of Century. *Steel*, Vol. 92, Jan. 2, 1933, pages 82-83. Tabulates production of pig-iron and steel ingots and castings in the principal producing countries for 1913, 1924-32; exports and imports of principal countries, 1913, 1929-32; and per capita production in United States, 1880, 1890, 1900, 1910-32. In 1932, U. S. output per capita was 242 lb. MS (15a)

The Outlook for Silver; Present and Future. C. W. HANDY. *Mining & Metallurgy*, Vol. 13, Dec. 1932, pages 519-520. Production of mined Ag for 1932 amounted to about 155 million oz., a shrinkage of over 105 million oz. from 1929 production. Ag from bullion is less unfavorable. Consumption in the arts and industries in U. S. and Canada is about ¾ of total. Consumption in India and China is estimated at about 50 million oz. Author predicts that for the present Ag prices will fluctuate within a range of 26 to 30c. Future of Ag depends on economic conditions, which will probably be upwards. VSP (15a)

What to Consider Before Relocating a Plant. R. M. FISCHER. *Iron Age*, Vol. 129, May 5, 1932, pages 1007-1009, adv. sec. page 24. Industrial migration is due to shift in population and markets, wider distribution of power, good roads, inequalities in taxes, and statutory restrictions. Relocation should not be undertaken without careful analysis of advantages and disadvantages of the move. Author outlines a logical and comprehensive procedure to follow. VSP (15a)

Zinc Metallurgy in 1931. F. G. BREYER. *Mining & Metallurgy*, Vol. 13, Jan. 1932, pages 35-36. Important developments during the year are: continuous retort operation, new electrothermic furnace, reduction with gas, by-product recovery, sintering progress and the revival of galvanizing. VSP (15a)

The Quality Question in the Non-ferrous and Gold-Platinum Industry of the U.S.S.R. during the Second Five Year Plan. D. M. CHZHIKOV. *Tzvetnuie Metallui*, No. 1, Jan. 1932, pages 82-93. (In Russian.) A suggested outline of developments in non-ferrous and rare metal industry for the second five year plan. BND (15a)

New Sources of Vanadium. B. M. SUSLOV. *Metal Progress*, Vol. 24, Aug. 1933, page 45. The writer describes development of new sources of V from titano-magnetite ore of the Ural Mts. WLC (15a)

Management Studies in a Mannesmann-Tube Works (Betriebsorganisatorische Arbeiten im Werk Rath der Mannesmannröhren-Werke) G. THELEN. *Archiv für das Eisenhüttenwesen*, Vol. 6, June 1933, pages 571-580. A detailed report on work organization, time studies, labor inspection, and cost accounting. SE (15a)

What Is the Outlook for Iron and Steel? ERNEST E. THUM. *Chemical & Metallurgical Engineering*, Vol. 40, Jan. 1933, pages 11-14. This is a statistical study of the output and consumption of steel. PRK (15a)

Improved Materials Widen Markets—A Review of Progress in 1932. HERBERT R. SIMONDS. *Iron Age*, Vol. 131, Jan. 5, 1933, pages 34-48; Pt. II, Jan. 12, 1933, pages 104-105, adv. sec, page 14. Discusses the development during the past year of steel, alloys, non-ferrous metals, castings, forgings, die castings, stampings, bearings and gears. VSP (15a)

Economic Aspects of Gold and Silver. SCOTT TURNER. *United States Bureau of Mines, Information Circular* 6740, July 1933, 13 pages. Three short addresses on Gold, The Best Year for Gold and the Worst for Silver, and A Review of Recent Discussion Regarding Gold Money. AHE (15a)

Economic Notes On Steel-Making Alloys. PAUL M. TYLER. *Mining & Metallurgy*, Vol. 13, May 1932, pages 225-228. Describes in relatively non-technical terms the growing and highly complex industry and the study of its relation to national progress. Use of alloys in making steel does not characterize the product as an alloy steel unless properties of steel are due to presence of elements other than C. Alloy steel production increased within 20 years from 500,000 to 4,000,000 tons in 1929. Among the minor alloys the most spectacular advances have been made in use of Mo. Discusses the use of ferromanganese, ferrosilicon, ferrophosphorus, ferrochrome, Ni, W, Mo, V and ferrovanadium. Includes tables giving production of ferro-alloys for a number of years. VSP (15a)

Scrap and the Copper Market. SAMUEL TZACH. *Engineering & Mining Journal*, Vol. 134, July 1933, pages 293-295. Secondary metal steadily assumes greater importance. The relationship of U. S. secondary Cu and virgin Cu is shown in a table. "Scrap" is defined as "salvage material arising from replacing or repairing power, trolley, and telephone lines, and from wrecking houses, machines, automobiles, battleships, etc." WHB (15a)

First Gold-Copper Bashkir Combine. A. A. TZEIDLER. *Tzvetnuie Metallui*, Feb. 1932, pages 251-260. (In Russian.) The Combine occupies an area of about 20,000 sq. kilometers with estimated amount of 300,000 tons of metallic Cu. The ores are rich, the Cu content being from 1.65 to 6%. Mining methods, the existing smelters, and the projected development and construction of the works are described. It is planned to increase the capacity of the smelters to 3,000 tons of ore daily (60,000 tons of metallic Cu per year). BND (15a)

Stabilize Foundry Costs Through Accurate Control of Variables. H. W. DIETERT. *Foundry*, Vol. 60, July 1932, pages 51-52. Abstract of paper read before the New England Foundrymen's Association. Foundry control should incorporate the following: (1) Purchase of raw material in specification that will assure uniform quality; (2) Inspection of all raw material; (3) Use of raw material in uniform weights and volumes; (4) Treatment of raw material in definite routine methods; (5) Performance of production operation to an exactness that is standardized within close tolerance; (6) Maintenance of equipment; and (7) Cost system to determine departmental and total cost of each casting. VSP (15a)

Economic Significance of Charging and Yield in Foundries (Die wirtschaftliche Bedeutung der Gattierung und des Ausbringens für die Giessereien) GEISSEL. *Die Metallbörse*, Vol. 22, Sept. 10, 1932, pages 1165-1166; Sept. 17, 1932, pages 1197-1198; Sept. 24, 1932, pages 1229-1230. The furnace balance for castings between 1 and 5,000 kg. (subdivided into 12 weight classes) is summarized showing an increasing yield and economy the larger the castings. The use of the chemical analysis is stressed for improving the economy with particular reference to high grade castings. The prices of 4 different furnace charges made from hematite, pig and scrap iron are given showing the possibility of saving. A wealth of data and formulae as basis for cost sheets relating to German conditions are presented. EF (15a)

The Influence of Furnace Size on Fuel Consumption in Pig Iron Production. EDGAR C. EVANS. *Iron & Coal Trades Review*, Vol. 126, Feb. 24, 1933, pages 296-297. See *Metals & Alloys*, Vol. 5, Jan. 1934, page MA 32. Ha (15a)

Pattern Costs and Molding of a Separator Casing (Modellkosten und Form zu einem Separatorgehäuse) ARNO. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, Jan. 21, 1934, pages 39-41. For a separator casing author calculates molding costs (1) in pattern molding, (2) in sweep molding. Sweep molding is then considered in detail. Sweep molding of piece considered is more economic. GN (15a)

Aluminium: A Survey of the Industry, its Present Position and Future Prospects. G. A. ANDERSON. *Metal Industry*, London, Vol. 44, Jan. 12, 1934, pages 41-45. Organization of Al industry in Great Britain is described, types of Al alloys and their use in the fields of railroad transportation and flying machines discussed. The importance of Al as alloying constitutent in Fe and ferrous metals is pointed out. Ha (15a)

Office and Business Methods in the Modern Foundry. S. HOWARD WITHEY. *Metal Industry*, London, Vol. 42, Mar. 3, 1933, pages 249-250; Vol. 44, Jan. 26, 1934, pages 111-112. The principles of store accounting are explained and forms developed keeping exact account of kind, quantity, quality and cost of castings made. Ha (15a)

The Tin Industry: Its Organization and Prospects. *Metal Industry*, London, Vol. 44, Jan. 12, 1934, pages 37-38. Statistics of production and consumption in 1933, prices and world stocks. Domestic uses of Sn and especially pewter are growing. Ha (15a)

Tin in the Telephone Industry. *Tin*, Dec. 1933, pages 4-5. Statistics on the consumption of Sn in different countries are given; it is used in cable-sheathing alloys, tinning of wires for preventing corrosion and in solders. Ha (15a)

Tungsten Industry (L'Industrie du Tungstène) *La Technique Moderne*, Vol. 25, Aug. 1, 1933, pages 526-527. Article is of economic character. After a short history of this industry, figures are given which show that China is the greatest producer in the world whereas U. S. A. and Germany use the greater part of W. Before the war, most of ores arrived at Hamburg and were treated in Germany but today New York holds same importance as Hamburg where W ores are concerned. American plants use W ores directly in blast-furnace whereas some others prefer to manufacture ferro-W in a special foundry. Price fluctuation since 1900 is explained and it is thought that world consumption exceeds China's capacity of production. FR (15a)

Code of Fair Competition of the Iron and Steel Industry as Approved by Executive Order of the President, Aug. 19, 1933. *Steel*, Vol. 93, Aug. 28, 1933, pages 17-26, 69-70. Text of code submitted to the NRA. MS (15a)

Exports Turn Spotlight on Scrap; Look for New Supplies. *Steel*, Vol. 92, Apr. 10, 1933, pages 11-12, 41. Discusses scrap situation. Includes table of exports in gross tons to the principal countries for 1923-1932. A total of 227,522 tons was exported in 1932, Japan taking 164,001 tons. MS (15a)

The German Non-Ferrous Metal Trades. *Metal Industry*, London, Vol. 44, Jan. 12, 1934, pages 49-52. Organization, exports and imports are discussed, Germany importing a great amount of non-ferrous metals. Copper and silver mining is briefly outlined, and trading opportunities for British products outlined. Ha (15a)

The Copper Industry: Its Resources, Markets and Prospects. *Metal Industry*, London, Vol. 44, Jan. 12, 1934, pages 29-33. Development of Cu production in different countries is discussed, Canada and Rhodesia being now among the foremost producers. Uses of Cu in transport industries (fire boxes, etc.), electrical applications, and lately more and more in the building trades are described. Ha(15a)

The Lead Industry: Its Resources, Scope, and Prospects. *Metal Industry*, London, Vol. 44, Jan. 12, 1934, pages 39-40. Statistics on production, consumption and prices. A brief historical sketch of uses of Pb, which dates back to 3000 B.C. is given; one of the latest alloys, Pb with 0.02 to 0.1% Te, has shown to possess considerably higher corrosion resistance than Pb; the temperature of recrystallization is raised which enables the alloy to be work-hardened at ordinary temperatures. Ha (15a)

Sierra Leone Iron-Ore Field. *Engineering*, Vol. 136, Nov. 24, 1933, page 574. Recently the first cargo of iron ore from Sierra Leone was shipped to Glasgow. The ore was discovered here in 1927 and averages 57% iron and 0.04% P. The Marampa ore deposits are worked by open-cut quarrying. LFM (15a)

Steel Trade Reorganization Plans. *Engineer*, Vol. 156, Dec. 15, 1933, page 597. Editorial commenting on the duties of and difficulties encountered by the National Committee formed 18 months ago to bring the British steel trade to the point of being able to meet foreign competition in the home and export markets. Since import duties were imposed steel production has increased from 45% to 70% of capacity. LFM (15a)

Non-Ferrous Metal Statistics. *Engineer*, Vol. 156, Sept. 1, 1933, page 208. Gives a summary of figures of the world's production, consumption and prices of 1932 from a report issued by the Metall Gesellschaft of Frankfort-on-Main, Germany. LFM (15a)

Mining Operations and Statistics. *Annual Report Quebec Bureau of Mines for the Calendar Year 1932*, part A, 1933, 158 pages. Of the total value of output (\$24,557,066) 52% was metallic, the largest proportion ever recorded in Quebec. AHE (15a)

Historical (15b)

79 Year Old Pipe Line Replaced. DONALD C. CALDERWOOD. *Water Works Engineering,* Vol. 86, May 17, 1933, pages 405-407. Pipe was cast in the foundries of Williams, Bird & Co. in Nashua, N. H., one of the leading iron and steel centers of that time. The pipe had no protective coating and was cast in a horizontal position. The iron was fine grained and the castings were symmetrical in shape. The overall length of the pipe was 9'5", the inside diam. 10", outside diam. 11", thickness ½", weight 510 lbs. or about 57 lbs./ft. The pipe had a pressure of 50-55 lbs./in.^{2} and occasionally pressures of 75-80 lbs./in.^{2}. Present day class "A" pipe of similar thickness and weight is recommended for pressures not exceeding 43 lbs./in.^{2} CBJ (15b)

Twenty-Five Years' Progress in Metallurgy at Broken Hill, N.S.W. M. R. McKEOWN. *Chemical Engineering & Mining Review,* Vol. 26, Oct. 5, 1933, pages 11-18. Historical. WHB (15b)

Progress in the Metallurgy of Gold. B. H. MOORE. *Chemical Engineering & Mining Review,* Vol. 26, Oct. 5, 1933, pages 43-45. Developments, during the past quarter century, in crushing and grinding and in Au extraction are noted. WHB (15b)

Göransson's Contribution to the Bessemer Process. *Metals & Alloys,* Vol. 4, Sept. 1933, pages 143-144. A letter from K. F. Göransson, grandson of G. F. Göransson briefly recounts the work of the elder Göransson in the development of the Bessemer Process. WLC (15b)

The First Iron Bridge. FRED BLAND. *Edgar Allen News,* Vol. 11, Apr. 1933, pages 240-241. Built in 1779 in Shropshire, England. Span 100 ft. 6 in., height from base line 40 ft., cast iron used weighs 378 tons. Historical data on erection are compiled. Ha (15b)

Beginnings of the Steel Foundry in the United States (Les Débuts de la Fonderie aux États-Unis) DELCROISETTE. *Revue de Fonderie Moderne,* Vol. 27, May 25, 1933, pages 147-148. Brief historical sketch of development of steel-casting industry and principal men in it. Ha (15b)

Development of Rolls and Rolling Mills. H. E. COOKSON. *Iron & Coal Trades Review,* Vol. 127, Oct. 6, 1933, page 520. A review of British development and a brief history. Ha (15b)

Iron in the Early Ages. C. H. DESCH. *Foundry Trade Journal,* Vol. 49, Aug. 3, 1933, page 67. Reproduction of letter to "The Times" (London), pointing out that what appears to be manufactured iron has been discovered during excavations at Tel Asmar. The find is stated to be of the same period as those at Ur and Kish. OWE (15b)

Primitive Wrought Iron Manufacture. GORDON SPROULE. *Metals & Alloys,* Vol. 4, No. 9, Sept. 1933, pages 144-146. Letter and pictures describe the primitive Catalan forge used in Ceylon for the production of wrought iron. WLC(15b)

Scientific Research—Its Possible Future Bearing on the Non-Ferrous Metal Industries. COLIN G. FINK. *Engineering & Mining Journal,* Vol. 135, Jan. 1934, pages 31-33. Historical. WHB (15b)

Iron in Egypt. G. A. WAINWRIGHT. *Edgar Allen News,* Vol. 12, Aug. 1933, page 293-295. The history of iron in Egypt is interestingly described. Long before the iron age set in in human history meteoritic iron was used by the Egyptians. Scraps of Fe were found in tombs which proved to be from a meteorite as they contain 10.9% Ni, 89.1% Fe. They date back as far as 3500 B.C. Ha (15b)

Metallic Materials in the Service of Speed (I Materiali Metallici al Sarvizio della Velocita) V. S. PREVER. *L'Industria Meccanica,* Vol. 15, Aug. 1933, pages 607-613; Sept. 1933, pages 665-670. A brief historical sketch of metals used in structures for high speeds (airplanes, vehicles) and their discovery is given and then the alloys made up of them which are now mostly used are described and their methods for working and heat treating discussed. Physical properties of alloyed steels and light metals are tabulated. Ha (15b)

Tin's Other Personality. *Tin,* Feb. 1933, pages 13-14. In a very interesting manner the anonymous author contrasts America and France as having all the gold and the British Empire having almost all the tin, from which fact he develops ideas of paying the reparation and intergovernmental debts in tin and eventually even developing a tin standard; the latter, he avers, exists in fact in Bolivia as there the rate of exchange depends on the price of tin. In a brief historical review he points to the fact that Sn has been used and struck as money several times, first perhaps in Syracuse under Dionysius, and even as late as in the reign of Charles II until 1860. Ha (15b)

Molding and Casting Technique in Prechristian Times (Form- und Giesstechnik in vorchristlicher Zeit) E. PIWOWARSKY. *Die Giesserei,* Vol. 20, Mar. 17, 1933, page 113. Historical sketch. Oldest cast metals were Cu used by the Sumerians, the original non-semitic inhabitants of Mesopotamia. Casting was developed further by Egyptians and Assyrians and found its climax during the Greek Periclean period. Bronze was used more by the Mediterranean peoples. Ha (15b)

Forgotten Pages of Tin History. *Tin,* Aug. 1933, pages 14-15. Recalls some facts of mining and marketing of Sn and gives some statistics of consumption from 1650 to 1850. Ha (15b)

Pewter Versus the Big Machine. *Tin,* Oct. 1933, pages 6-8. A revival of pewter ware by individual craftsmen in spite of general mass production is noticed. A history of pewter craftsmanship is given. Ha (15b)

Bells and Bell Ringing. *Tin,* Nov. 1933, pages 10-11. Brief historical remarks about bells and carillons, their casting and tuning. Ha (15b)

Ancient Tin Coinage in Malacca. *Tin,* Nov. 1933, pages 9-10. Coins found when digging trenches were of tin and made apparently in the early 16th century under Portugese possession. Ha (15b)

Fifteen Years of Non-Ferrous Metal Industry in the U.S.S.R. *Tzvetnuie Metallui,* Sept. 1932, pages 3-30. In Russian. The development of the non-ferrous metal industry in Russia for the last 15 years is reviewed from the statistical, economical and technological viewpoints. BND (15b)

Steelmaking Processes. GEORGE B. WATERHOUSE. *Transactions American Institute Mining & Metallurgical Engineers, Iron & Steel Division,* Vol. 105, 1933, pages 13-27. This is the Howe Memorial Lecture delivered in Feb. 1933. The relative amounts of steel produced in this country by the various methods during the past 20 years are given and the reasons for the trends in tonnage discussed. Attention is also paid to the origin of the various processes. JLG (15b)

Some Steps in Metallurgical Progress, 1908-1933. WALTER ROSENHAIN. *Institute of Metals,* Advance Copy No. 647, Sept. 1933, 18 pages; *Metal Industry,* London, Vol. 43, Sept. 22, 1933, pages 277-281. Reviews advancements in non-ferrous metallurgy. Progress of both theoretical and practical metallurgy are discussed. Emphasis is on work of British investigators and on work described in *Journal Institute of Metals.* 40 references. Ha + JLG (15b)

Twenty-Five Years' Progress in Metallurgical Plant. W. R. BARCLAY. *Journal Institute of Metals,* Vol. 53, Oct. 1933, pages 127-146; *Metal Industry,* London, Vol. 43, Sept. 22, 1933, pages 263-270. Developments in melting and casting equipment, rolling machinery, wire drawing plants and furnaces are reviewed and many illustrations of historical value and most modern machinery of all countries shown. Ha (15b)

Five Years of Welding Instruction Classes in Berlin (Fünf Jahre Grosslehrwerkstätten Berlin) H. A. HORN. *Autogene Metallbearbeitung,* Vol. 26, Apr. 15, 1933, pages 113-117. Equipment and courses are described for teaching practically the whole field of welding technique; statistics of students. The school is open also to graduates for working out their doctor theses. Ha (15b)

Faraday and His Electrochemical Researches. R. S. HUTTON. *Metal Industry,* London, Vol. 43, Sept. 29, 1933, pages 329-330; Oct. 13, 1933, pages 379-380. Sketch and appreciation of his work. Ha (15b)

Copper and Bronze in the Middle Ages (Le Cuivre et le Bronze au Moyen Age) H. BREAU. *Cuivre et Laiton,* Vol. 6, Sept. 1933, pages 427-428. Brief historical sketch on the uses and working processes of Cu, bronze and brass for practical purposes and in art and decorative purposes from the 5th to the 16th centuries. Ha (15b)

Ancient Egyptian Materials and Industries about 1350 B.C. A. LUCAS. *The Analyst,* Vol. 58, Nov. 1933, pages 654-664. Includes metallurgy. AHE (15b)

Historical and Technical Notes on the Greatest Statue of Hammered Copper in the World, "Liberty Illuminating the World" (Notes historiques et techniques sur la plus grande statue du monde en cuivre martele, "La Liberte eclairant le Monde") A. CHAPLET & J. B. GAUTHIER. *Cuivre et Laiton,* Vol. 6, June 30, 1933, pages 297-304. Detailed description of the manufacture of the Statue of Liberty. Ha (15b)

James Beaumont Neilson, Biographical Note. J. MALBORN. *United Effort,* Vol. 13, Dec. 1933, pages 8-10. Comment on introduction of hot blast at Clyde Works blast furnace, Glasgow, about 1817, and the subsequent development of water-cooled tuyeres. A drawing of Neilson's blast furnace plant is included. The hot blast made available much Scotch ore that could not be smelted by cold blast and first produced really cheap pig iron. Neilson was also a pioneer in workmen's education, and is alleged to have established the first real class in electrical engineering. HWG (15b)

The Iron and Steel Industry and Its Relation to Structural Engineering. G. W. COSTAIN. *Journal & Record of Transactions of Junior Institution of Engineers,* Vol. 43, Feb. 1933, pages 207-215. Paper before the Midland Section of the Institution exhaustively deals with the utilization of Fe in Great Britain during the middle-ages and traces the history up to the present time. While ferro-concrete forges ahead on the continent, structural steel dominates in England so far as buildings are concerned. The speaker admits that the former stands unchallenged in certain structures such as tanks, reservoirs, retaining walls, silos and road bridges, but for factory construction and multiple story building, the latter material is economical, more rapid of erection and adaptable for the requirements of the buildings of which it forms a part. The great advance due to welding, stainless steels and Cu-bearing steel are stressed. The speaker feels that the "reversion to Bessemer basic steel to combat the evil of imported continental steel is a possible development." WH (15b)

Thirty Years' Change in the Iron Industry of Southern Westphalia (30 Jahre Wandlung in der Eisenindustrie des Siegerlandes) H. KLEIN. *Stahl und Eisen,* Vol. 53, Nov. 2, 1933, pages 1125-1133. Production and operating statistics are given in 10 charts showing iron ore, pig iron, steel ingot production, etc., for the last 30 years. The periods between 1900-13 and 1924-32 are separated into two groups with a blank space for the war years to 1924. Most of the post-war figures are lower than for the years before the war, with a further sharp decline since 1928. A notable exception is in the production of sheet which was appreciably higher after the war than before, and has not declined so greatly since 1928. SE (15b)

Developments During Past 60 Years in Manufacture of Materials Employed by Structural Engineer. T. H. BEARE. *Structural Engineer,* Vol. 20, Feb. 1932, pages 80-83. The larger part of this historical review pertains to a discussion on structural steel, besides Portland and reinforced cement, with emphasis on British contributions. WH (15b)

Copper and Bronze in Antiquity. (Le Cuivre et le Bronze dans l'Antiquité.) H. BRÉAU. *Cuivre et Laiton,* Vol. 6, May 15, 1933, pages 225-226. Historical sketch of use of Cu and bronze; Cu can be traced back to the year 4000 B. C., bronze to 1200 B. C. Alloys used in those times consisted of Cu, Pb and Sn. The old Greek (Attic) bronzes consisted mostly of 62% Cu, 32% Sn, 6% Pb, while the Romans used up to 84% Cu and as little as 10% Sn. Methods of casting and making jewelry are reviewed and a few literary references given. Ha (15b)

Gold Inlays. JOHN SCHOLTEN. *Journal American Dental Association,* Vol. 21, Jan. 1934, pages 66-75. According to author cast gold inlays were described by Philbrook in 1896-97 but received little attention until they were again developed and described by Taggart in 1907. The remainder of the paper gives details for the production of cast gold inlays of accurate dimensions, making use of information obtained from the research work at the National Bureau of Standards. OEH (15b)

The Lead Mines of the Peak. GILBERT E. SMITH. *Metal Industry,* London, Vol. 42, June 16, 1933, page 609. Historical data on the ore mines in Cornwall, England, some of which were worked by the Romans for Cu and Sn. Later Pb and some Au was mined. Ha (15b)

The Historical Development of Furnaces. HERBERT SOUTHERN. *Edgar Allen News,* Vol. 12, Sept. 1933, pages 313-315; Oct. 1933, pages 330-333; Nov. 1933, pages 345-347; Dec. 1933, pages 357-359; Jan. 1934, pages 374-376. A complete history of methods and developments in melting iron and other metals with many illustrations from ancient times up to the present is given. Fuel-fired and electrically-heated furnaces and their control arrangements of automatic operation are discussed. Ha (15b)

A Century of Progress—In Iron and Steel Industry. *Steel,* Vol. 93, July 3, 1933, pages 11-12. Chronological outline of outstanding events in the American iron and steel industry from 1833 to 1933. MS (15b)

A Book of Old Engineering Technique; The New Edition of Diversarum Artium Schedula of Theophilus Presbyter (Ein Buch von alter Technik; zur neuen Ausgabe der Diversarum Artium Schedula des Theophilus Presbyter) O. JOHANNSEN. *Zeitschrift Verein deutscher Ingenieure,* Vol. 78, Feb. 3, 1934, pages 153-155. The "Diversarum Artium Schedula" is principally a description of old handicraft and explains old processes of metal working, glass-melting, melting and casting of iron. It was written in the 10th century by a monk, Theophilus Presbyter, very likely in the Pantaleon Abbey in Cologne. The old technique of artcraft in ivory, glass staining and sculpture are particularly interesting. The old text, mostly Latin interspersed with Greek words, has been translated and edited by Dr.-Ing. Wilhelm Theobald. Ha (15b)

Card Wire. KENNETH B. LEWIS. *Wire & Wire Products,* Vol. 9, Feb. 1934, pages 44-46, 60-61. An outline of the history and development of card wire is given and modern operation in making cards and their application in other than textile industries are described. Ha (15b)

Old Blast-Furnace in France (Les Anciens Hauts-Fourneaux de France) G. LAHAYE. *La Fonte,* Vol. 2, Jan. 1933, pages 225-239. Blast-furnaces built before 1872, i. e. before discovery of Thomas process, are described. FR(15b)

Permanent Magnets. R. A. CHEGWIDDEN. *Bell Laboratories Record,* Vol. 12, Jan. 1934, pages 130-134. Some historical remarks; selection of material for making and methods of magnetizing permanent magnets are discussed. Ha (15b)

Early Sheet and Tin Plate Making. *Sheet Metal Worker,* Vol. 25, Jan. 1934, pages 10-12. A history of tin-coated iron industry is outlined; tin-coated vessels were mentioned as early as 26 A.D. by Pliny. Up to 1720 only small pieces were made by hand, in this year the development of the industry on a large scale began in England. From then on development in each country spread rapidly. Ha (15b)

NEWS NOTES

Broad Program of Tin Research Started in United States

Following out an extensive and continuous research program in the world's principal tin using countries, The International Tin Research and Development Council has announced definite plans for carrying on this work in the United States.

On the recommendation of D. J. Macnaughtan, Director of Research for the International Council, the Battelle Memorial Institute, Columbus, Ohio, has been appointed to conduct research projects on tin in this country. Work is reported to be well under way, following such lines of investigation as will be of the greatest value to American manufacturers who employ tin for various purposes.

As Mr. Macnaughtan pointed out in an address to the American Tin Trade Association not long ago, an analysis of the major applications of tin in industry, reveals the fact that its chief use is in conjunction with copper, lead, and steel, and in the production of these metals the United States leads the world. A wide application in the use of tin is also found, in this country, in the form of chemical compounds affecting many industries. Technical problems, covering a number of new uses, will also be studied.

The Battelle research organization with its large technically-trained staff and modern completely equipped laboratories will coöperate closely with the New York office of the Council, the Bureau of Information at London, and the Statistical Branch at The Hague.

Members of the International Council include the four leading tin-producing countries—Malaya, Bolivia, Netherlands East Indies, and Nigeria. Tin, one of the world's oldest metals, was used by the Phoenicians and relics of early civilization include implements made of tin and copper, showing a knowledge of alloys ages old. It is also known that after the Roman conquest of Britain quantities of tin were transported to Italy.

Although tin is centuries old and a metal of far-reaching, highly-developed uses, its growing importance in this scientific age has led to a broad international research program in which much new information has already been uncovered. Due to the eminence of the United States in industrial development, the research work now in progress at the Battelle Memorial Institute is regarded as one of the most important steps in the Council's program.

Edwin Lewis Crosby

Edwin Lewis Crosby, President, Director, and founder of Detroit Electric Furnace Company, died Saturday, May 5, at Ludlow, Massachusetts, as a result of injuries received in an automobile accident. Mr. and Mrs. Crosby were motoring from Boston to Buffalo on May 2, when their car collided with a truck. Mrs. Crosby, who was also injured, is recovering. Mr. Crosby was born 53 years ago in Plymouth, Michigan. After graduating from Plymouth High School, he went to work for the Semet Solvay Company in Detroit. Later, he completed successfully a course in Electrical Engineering and for several years was in charge of electrical operations in the Semet Solvay plant. In 1905, Mr. Crosby entered the employ of the Detroit Edison Company. For 13 years he was chief power salesman. Leaving the Edison Company in May 1918, Mr. Crosby organized the Detroit Electric Furnace Company of which he became Vice President and General Manager. In 1920 he was elected to the Presidency of the Company. Mr. Crosby has been an active member of the Electro-chemical Society for many years. He was also a member of the Foundrymen's Association and a frequent contributor to foundry and electrical engineering trade journals. His enthusiasm and interest in the field of electric melting was communicated to utilities, foundries, and industrial concerns. His courage and ability in this new industry stamped him as a pioneer in electric melting problems. Mr. Crosby is survived by his wife, Mrs. Irene Crosby; a daughter, Mrs. Joseph Labadie of Windsor, Ontario; and a son, Lewis T. Crosby of Detroit.

Dudley Medal Awarded to R. L. Templin

The Charles B. Dudley Medal for 1934 will be awarded to R. L. Templin, Chief Engineer of Tests, Aluminum Company of America. This medal is awarded annually to the author of the paper presented at the preceding annual meeting which is of outstanding merit and constitutes an original contribution to research in engineering materials. Mr. Templin's paper was entitled "The Fatigue Properties of Light Metals and Alloys."

Twenty-fifth Anniversary of Book Publisher

The McGraw-Hill Book Company have published a souvenir booklet commemorating the twenty-fifth anniversary of the company. For twenty years, the books published were confined broadly to the fields of applied science, in 1930 a trade division was formed. To distinguish these from the technical books, the name of Whittlesey House was adopted.

EDITORIAL COMMENT

(Continued from page 117)

were instituted and a satisfactory treatment was decided upon and tested out so that the work was completed and the Committee discharged within the estimated time. *Refrigerating Engineering* estimated a few years later that this work was saving the refrigerating industry nearly a million dollars a year.

The Physical Chemistry of Steel Making is an example of a problem that had not received sufficient or systematic attention by individual steel manufacturers. In 1926 the U. S. Bureau of Mines, Carnegie Institute of Technology, and several of the leading manufacturers became associated on a Metallurgical Board with the object of studying the fundamentals of making cleaner steel by the open hearth process. This work, under Dr. C. H. Herty, Jr., is now nearing completion and is too well known to require description here. The original object seems to have been attained and the information and data applied successfully in different ways in a number of plants. The results have been favorable both as regards economy of operation and quality of the product. In the meantime, individual research work has been stimulated to a much larger degree as a result of the publicity accorded this work. The annual public conference and discussion on this work was attended last year by about four hundred metallurgists. On the present Metallurgical Board problem, about $400,000 have already been expended, including the contributions of the Bureau of Mines, Carnegie Institute of Technology (in cash and kind) and the cash contributions from the manufacturers.

This work has also demonstrated to some executives the value of concentrated research. The main question now arises whether company funds available for research can best be expended individually or by contributing to coöperative work. This may possibly tend to encourage expenditures for individual work instead of contributing towards coöperative work. If this point of view should prevail too generally it would be unfortunate. Both are necessary to progress. The intangible benefit of being associated with others on problems of general interest should not be overlooked.

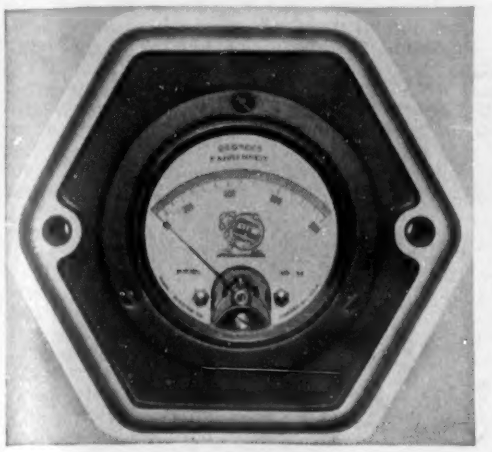
For a successful handling of coöperative problems on fundamentals, there are required: A clear-cut recognition of the problem, sufficient financing, the right kind of direction, and a sense of when to stop and turn over the results to the industry to work out the details of practical application.—F. N. Speller*

*Director, Department of Metallurgy and Research, National Tube Company, Pittsburgh, Pa.

NEW EQUIPMENT and MATERIALS

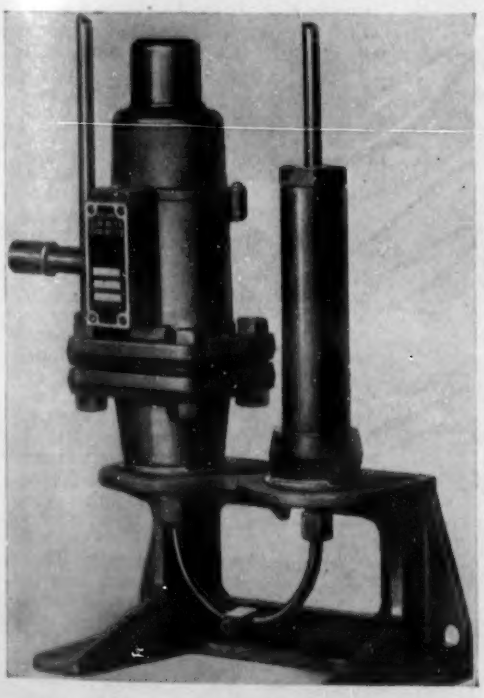
New Indicating Pyrometer

The Russell Electric Company, Chicago, Ill., have designed a new self contained pyrometer, with the thermocouple extending directly from the hexagonal-cased indicator to the point of temperature measurement in the oven, furnace, kettle, etc. Thus, there are no "connection leads" but the "extension leads" may be attached to the top, bottom or either side of the 5⅝" case as specified. Alternatively, the "Hold Heet" pyrometer may be supplied in the form of a portable straight lance with aluminum handle. A distinctive characteristic is the 10-ohm resistance of the measuring element, together with the low resistance of the heavy-gage thermocouples. The total variable external resistance is said to be 1/150 of the measuring-element resistance, and the different couples are all so nearly alike in ohmic values that the instruments are uniformly calibrated for their average resistance. This mass-production method is said to give a maximum possible error of "even less than one part in 150" and it has made it possible to produce rugged pyrometers "at unheard-of low prices" especially for manufacturers of heat-process equipment. Two standard ranges have been announced: 60°-800°F. and 60°-1600°F.

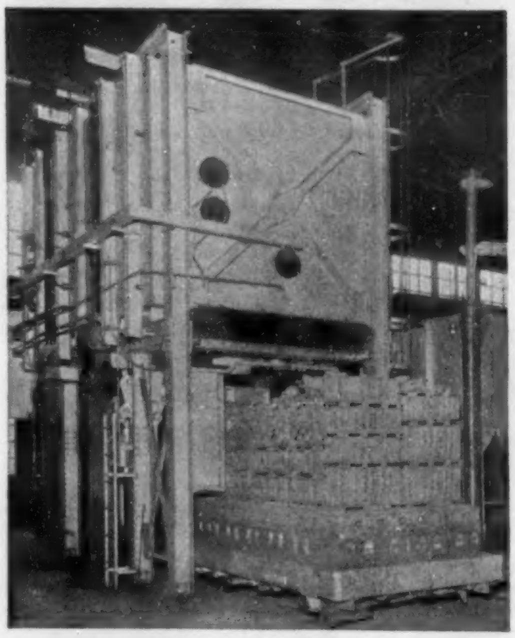


New Electric Meter Body

The Brown Instrument Company, Philadelphia, Pa., announces a new meter body for electric flow meters. It is designed for measuring the flow of any liquid, vapor or gas creating a differential pressure across an orifice of 1.6" to 16" mercury. The outstanding features of this meter body are ease of cleaning and range changing, combined with ruggedness and simplicity. A seamless steel "U" tube with union compression fittings connects the high and low pressure chambers. A mercury drain mounted on this tube has a hardened needle point screw which seals the mercury drain hole in the "U" tube. Mercury cannot be blown out of this meter body under severe overload or reverse flow conditions. Two highly resilient seals of an oil resisting material, seat firmly in the high pressure chamber, one seal on top the float, one underneath. As the mercury level rises and falls with flow changes, the float in the high pressure chamber is free to move and accurately follows the mercury level. Movement of the float is transmitted electrically to the indicating or recording meter. Forged steel pressure chambers are used in this meter body, heavy seamless steel tubing for the range tube—"U" tube—and piping, with all copper gasketed fittings recessed, eliminates welding. Four size ¾" specially heat treated nuts and bolts (ultimate strength over 100,000 lbs.) join cover to high pressure chamber. Rugged construction permits working pressures to 2500 lbs./in.². Each meter body tested to 5000 lbs./in.² before leaving factory. The base of the meter body is interchangeable for wall or floor mounting and made of malleable iron to stand shocks on severe applications. All parts and fittings mounted on the base are open and easily reached with a wrench, which enables quick cleaning or range changing. The range of this meter body can be changed quickly, easily and cheaply without shutting down the line. An external pulsation check is designed for precision adjustments with the meter body under full line pressure (2500 lbs./in.²). The pulsation check and mercury drain are one unit. The mercury drain may be opened and closed, carrying the pulsation check with it but not changing the setting.



Short Cycle Malleablizing Electric Furnace



A short cycle malleablizing furnace which reduces the total time for heat treatment from the conventional 6, 8 or 10 day period, to 72 hours or less, is announced by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. The heating up of the charge is done at night, during off-peak load, with only radiation losses supplied during the day: Furnaces range from ½ to 25 tons, with maximum night time electrical loads of 40 to 600 kw., and corresponding electrical capacities of 13 kw. to 75 kw. during the daytime. Energy consumption for the 72 hour malleablizing cycle per gross ton of charge (castings and boxes when required) is:

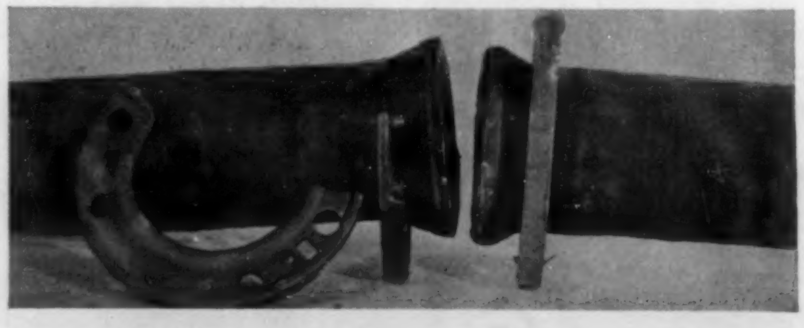
25 ton furnace	375 kw.-hrs. per gross ton
12 ton furnace	450 kw.-hrs. per gross ton
7½ ton furnace	500 kw.-hrs. per gross ton
1 ton furnace	625 kw.-hrs. per gross ton
½ ton furnace	775 kw.-hrs. per gross ton

Since a definite time-temperature cycle is laid out, depending on the chemical analysis of the iron, every casting must be of the highest quality as to tensile strength, elongation, and machinability, for the particular analysis. Any up-to-date plant having average melting supervision and analysis control may employ successfully this 72 hour annealing cycle. Twenty-six hour cycles have been obtained by companies having these furnaces in operation on castings ½" thick and where the analysis is carefully controlled.

Packing materials and heavy cast iron pots are not required. Some castings may have to be annealed in boxes, but without the use of packing material. These include castings that will not withstand much weight without danger of warpage, or small castings that cannot be stacked up on the car in sufficient quantity to produce a full charge. Boxes made of ⅛" sheet steel have been in commercial use for 240 heats without signs of scaling.

New Construction in Hose Joints

A new hose joint which eliminates all contact between metal and fluid has recently been patented by The B. F. Goodrich Rubber Company, Akron, Ohio. This construction is said to permit greater flexibility than any other type of coupling or joint and affords a perfect seal in all suction service and discharge service up to 125 lbs. working pressure. The Goodrich "Flexseal" joint is designed particularly as a substitute



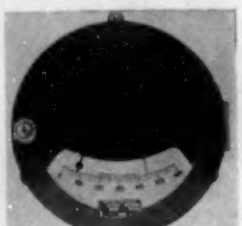
for nipples and flanges. It is recommended particularly for the larger diameters of suction or discharge hose handling abrasive materials and hose handling acid or other corrosive liquids. The success of the joint is dependent on the unique end which is built into the hose. This end consists of an enlargement, or bead, reinforced with numerous plies of fabric surrounding a rigid steel ring of angular cross section. The joint is assembled with the aid of split flanges and standard bolts. Two successive lengths of hose can thus be bolted together with the rubber ends of the hose compressed to form a seal. The spacing of the bolt holes is standard so that the end of the hose can be fitted to the end of a standard pipe. When the bolts are drawn up the pressure of the split flange against the flared hose end provides a positive and unyielding clamping of the joint. The joints are furnished in sizes 1½" and up.

New Control Valve

The new Synchro diaphragm motor valve, developed by the Bristol Company, Waterbury, Conn., is intended primarily for use on air operated control systems. The valve responds immediately to air pressure changes, and the stem position for a given pressure is the same whether pressures are rising or falling. There is no hysteresis or friction loss in the top movement. These features are accomplished by correct design of the rubber diaphragm and top, precision measurements in the manufacture and assembly of the stem guides, accurate alignment and proper spring construction. The construction greatly simplifies maintenance and servicing of the valve. Ample space is provided for renewing stem packing without disturbing the adjustments. The top may be renewed or the spring replaced without changing the setting of the spring follower. Union and valve bodies of either V-port or single seated construction are available with body material and trim to meet the demands of almost any industrial process.

New Mercury-Switch Indicating Thermometer Controller

The Brown Instrument Company of Philadelphia, Pa., announce a new automatic control indicating thermometer. In this new controller, every 6 seconds a motor-driven control table determines the location of the pointer in reference to the control setting, and tilts the mercury switch from one side to the other if the temperature has changed. With this unique system, the measuring mechanism is free to position itself, unhampered by the control mechanism. There is no excess weight on the pointer, no distortion or restriction of pointer movement. The making of control contacts is not dependent upon friction, because the switch is positioned with a positive action by the electric motor. Contacts are unaffected by vibration because the mercury switch is mechanically locked in place until a different position is required. Corrosion and dirty contacts are eliminated as the switch is sealed in glass. These mercury switches have capacities up to 15 amps. at 110 volts (10 amps. at 220 volts), thus eliminating external relays in most applications. This control mechanism is adaptable to one-, two-, or three-contact control (or signalling) systems. The indicating control thermometers are equipped with the same measuring system and control mechanism supplied with the recording control thermometers. This type of instrument has given excellent service in installations where it was desirable to measure temperature at a distance up to 200 feet and at the same time control the temperature or signal an alarm when the temperature gets beyond certain limits. Scales can be read at a considerable distance. All models of this controller are furnished in circular 10-inch universal cases. This new Brown indicating controller is equally adaptable for control of pressure, liquid level, and similar factors, as well as temperature.



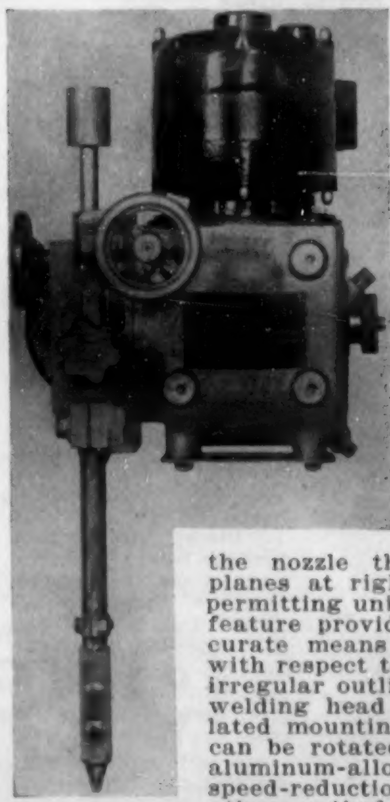
New Method for Resurfacing Rail Ends and Crossing Castings

D. B. Patterson, Executive Vice President, Harnischfeger Corp., announces a new method for building up worn rail ends. This process, uses a new type rod and flux and involves a new application of the arc. With electrodes mounted in suitable holder and inclined to the proper angle, the flame is projected past the positive electrode. This results in what operators call a "soft" flame without high pressure back of it and consequently no tendency to blow the metal. Electrodes are specially constructed, the positive being given a peculiar channel shape with a small core running through its entire length. The negative electrode has the conventional cylindrical shape with one end tapered to a fairly sharp point. The special new 3A filler rod used has a density of 8.28 to 8.30, a tensile strength up to 80,000 lbs. and the peculiar ability to withstand pounding action after being laid as a surfacing material.

In its ability to "work harden" it is not unlike 12-14% manganese steel excepting in its initial hardness. It will withstand pounding to an unusual degree without battering or bulging. A rail surfaced to a height of ⅛ inch showed a Brinell hardness of 223 to 235. After being struck 100 blows of 150 ft.-lbs. each, hardness increased to 300. Continued pounding increases hardness little beyond this point. Should initial or final work hardness be desired, this can be accomplished by a slight change in composition. However, tests show that too high hardness is not desirable because of the tendency to form small cracks. The preferred hardness for practical use is between 302 and 350. Although the oxy-acetylene and arc welding processes have served as a welcome expedient for most railroads in building up these battered rail ends, both methods present certain difficulties. The 12 to 14% manganese steel castings used as crossings require more time for welding operations than do rails. Only a small space may be laid and then peened with a hand hammer. On the other hand, although rails require less time, the heat developed is much more concentrated and is likely to thermally disturb the crystal structure of the parent metal. When this happens, the rail is apt to fail in service entirely. The rail end or crossing casting to be surfaced is first heated by the flame of the arc torch with the positive electrode held about an inch away and moved slowly back and forth. When sufficiently hot, a generous amount of flux is applied and further heated until a glazed surface appears. Without removing the flame, a rod is inserted and held there until it is just ready to melt and a drop to fall off. Then it is lowered to contact with the piece to be resurfaced. After a little experience the operator will know by the "feel" whether or not bonding action has taken place by rubbing the rod end lightly over the heated surface. During the bonding action, the flame should be concentrated by lowering closer to the work and moving slowly along the surface. The rod should be kept well within the flame at a point where it will not melt too rapidly, yet fast enough to properly adhere and smooth out in a bright molten pool. With a little practice, a well spread and even surface is obtainable.

The bonding action in this process is rapid and it is not essential that a pool be kept liquid for a long time to insure a strong bond. In fact, it is recommended that the temperature of the unit be kept as low as possible but to concentrate the required heat directly on its face. When a unit has been surfaced, no subsequent treatments are required. After an operator has developed sufficient technique, very little, if any, grinding will be found necessary in the ordinary run of work. No peening whatever is required.

Improved Automatic Arc-Welding Head



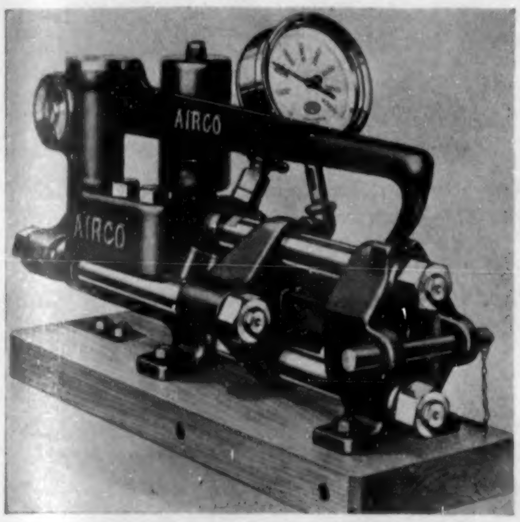
Simplicity of design, control, adjustment to work, and maintenance are said to be the features of the Type WFA automatic arc-welding head of the General Electric Company, Schenectady, N. Y. One small motor drives the electrode feed rollers through a simple worm reduction gear and three-speed transmission. At any of the three speeds, selected to suit electrode size, current, and rate of deposition of metal, the electrode is fed at a uniform rate and the arc voltage is accurately maintained. One small rheostat is the only adjusting element necessary. This means quick and accurate control of the electrode feed, as all other operations are fully automatic. Handwheels swing the nozzle through complete circles in 2 planes at right angles to each other, thus permitting universal motion of the head. This feature provides the simplest and most accurate means for positioning the electrode with respect to the work or for following an irregular outline as the weld progresses. The welding head complete consists of an insulated mounting support, an end plate which can be rotated and to which is attached an aluminum-alloy gear case containing the speed-reduction and transmission gears operating entirely submerged in grease. The motor is mounted vertically on the top of the gear case and is of the totally enclosed, ball-bearing type. It has adequate power, not only to feed the electrode but to straighten it as it comes off the reel. A circular aluminum-alloy plate carrying nozzle, wire guide, feed rollers, and feed-roller-pressure-adjusting knob is mounted on the left side of the gear case and can be rotated by means of a handwheel through a worm and worm wheel. A gear-shifting dial on the right side of the case permits ready selection of the desired transmission ratio. The electric control equipment consists of an enclosed panel on which are mounted standard G-E relays and contactors which maintain in proper sequence the operations necessary in starting, running, and stopping the automatic arc-welding head—and an instrument panel which may be located anywhere but preferably is placed as close to the welding position as possible. This instrument panel carries meters reading arc voltage and current, the arc voltage adjusting rheostat, start-stop buttons, a forward-reverse switch for the electrode feed mechanism, and a selector switch for either manual or automatic operation of a travel carriage if the latter is used. The standard Type WFA automatic arc-welding head and control is arranged for operation from a 60-volt d.c. supply.

Welded Stainless Tubing

The Carpenter Steel Company announces the arrangement of a distributor's franchise with Horace T. Potts Company, East Erie Avenue and D Street, Philadelphia, Pennsylvania, to distribute the products of Carpenter's Welded Alloy Tube Division located at 347 Madison Avenue, New York. These products consisting primarily of welded tubing made of Stainless Steel, will be handled by Horace T. Potts Company through the territory which they normally cover in eastern Pennsylvania, southern New Jersey, Delaware and part of Maryland.

Portable Testing Machine for Welding Work

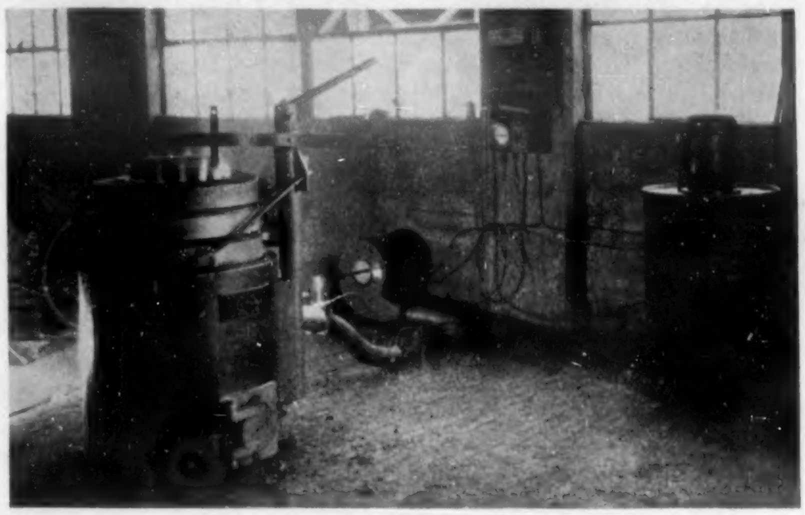
The growing demand for accurate knowledge of weld strength is the natural result of developments in welding. In fabrication and in pipe line work, engineers now consider it essential to know with close exactitude the actual strength of welds as they are made. Also knowledge that the welds are as strong as the plate being welded is frequently desired. The delay and complexity of shipping weld specimens to testing laboratories have brought about a strong demand for a compact, accurate and portable testing machine for use right on the job. In answer to this demand the Air Reduction Sales Company, New York, N. Y., has developed the Airco portable tensile and bend testing machine, which is a compact, comparatively light machine that can be carried right to the welding job so that welded specimens can be tested on the spot, rapidly and easily. The machine consists essentially of an oil pump, a hydraulically actuated piston or ram, two heads—one fixed and one movable—for gripping the test specimens, and 4 symmetrically located steel shafts, 2 of which transmit the piston motion and load to the movable head. The other 2 shafts maintain the alignment of the 2 heads, and prevent the introduction of bending stresses in the tensile test specimen. By means of a long lever attached to the pump, and the ratio between the areas of pump plunger and hydraulic ram, the downward force on the pump lever is magnified 400 times in the load applied to the test specimen. This magnification of the force applied to the pump lever, together with the large piston displacement of the oil pump, enables specimens to be tested rapidly and with a minimum of effort. The load on the test specimen is indicated on a 6-inch pressure gage of special construction, carefully calibrated against a standard dead weight tester. The gage is designed to maintain its accuracy under the strains of usage and shipping. The machine is calibrated, using clean lubricating oils covering the range of viscosities sufficient to assure that the viscosity of the oil does not materially affect the accuracy of the machine. Any good light crank case oil can be used. The oil chamber is provided with a filter to prevent any dust particles which may drop into it from entering the oil passages.



With a few strokes of the operating lever, after the specimen is set up, the operator can apply a direct load up to 40,000 lbs. to specimens from 9½" to 10" long, up to ½" thick, and up to 1½" wide. Then, by using specimens of smaller cross-sectional areas than the maximum 1½" by ½", higher strengths can be measured. With these reduced size specimens the whole range of various types of steel can be tested by this quick and easy method. The stroke of the movable head is up to 2¾", more than ample for practically any of the ferrous or non-ferrous metals. The operation of the machine requires but little effort. It is rapid, simple, and sure, and readings are accurate to $\pm 2\%$. For the bend test, the machine is provided with an anvil which fits into the movable head, and which bends the specimen against a pair of supports set 3" apart and cast integral with the body of the machine. An important feature of this testing outfit is its easy portability. A solid hardwood base upon which the machine is permanently mounted forms part of the packing case. Sides and top of the case are assembled with screws. A few minutes with a screw driver frees the machine for immediate use, or packs it for shipment to another job. A separate box contains the gage, carefully packed to protect it in transit. The entire unit, machine and case, weighs only a little more than 200 lbs. and can be handled freely without damage to the machine.

New Non-Ferrous Melting Furnace

A development in melting furnaces, of primary interest in the non-ferrous field, and known by the trade name "Meltomat" is being offered by the United Furnace Engineering Co., Inc., New York City. The furnace is of the crucible type, employing oil as fuel. Several unique features are found in the design which are direct outgrowths of an intensive investigation into the theory and practice of melting non-ferrous metals and alloys. These features center toward the thought of consistent automatic functioning for production of controlled quality metal at low operating cost and under comfortable working conditions. Outstanding among these features is a novel system of combustion. Each furnace is individually equipped with fuel and air supply units. Oil is supplied at extremely high pressure by a metering pump submerged in oil tank and driven by electric motor. The oil passes through a burner orifice of special design, resulting in atomization substantially to the vaporous state. Air is supplied at this point by a motor driven fan blower, the volume of air being under control of a shutter at the blower intake. The high order of oil atomization, together with effective mixture with air, results in rapid, clean com-



bustion which is practically completed in a short auxiliary chamber, leading to but distinct from the melting chamber proper. The refractories and crucible in the latter thus are not subjected to highly reactive gases, and maximum and equalized temperature is assured in the working zone. The contours of this zone are designed to assist in this distribution. Furnace temperature and rate of heat development are determined by rate of oil feed. Nature of furnace atmosphere is determined by volume of air supply. Both supplies are subject to adjustment by supervising authority for attainment of desired conditions. Once adjusted, the furnace may then be turned over to melter with assurance that standard conditions of combustion will be maintained. The melter starts and stops operation by throwing a single electric switch interlocked with hot air and fuel supply motors. Another furnace feature of interest and value is the provision of a hopper type cover which automatically feeds metal to the crucible as melting progresses. This design substantially isolates the melt from combustion gases, diverts to useful preheating service a large amount of energy usually wasted, and in many cases permits charging of furnace in one rather than successive operations. For adjustment of the equipment to desired condition of operation and for subsequent check on maintenance of same, a control board is provided at a convenient location. This carries an oil pressure indicator, a furnace atmosphere indicator and the start-stop switch. Stationary Meltomats, using American Standard crucibles, are available in any desired size. Tilting furnaces also are furnished in designs to meet specific shop requirements.

Rate of Heating Regulator

The Lindberg Control provides a means for "turning down the heat" on electric furnaces. Until the introduction of this instrument, electric furnaces were usually equipped merely with a push button "on" or "off." The heating rate of a furnace was built into it at the factory, and no practical means were available to change that rate.

The Lindberg Steel Treating Company, Chicago, Ill., using a large number of electric furnaces in their own plant, were faced with the problem of controlling the rate of heating in order that certain jobs could be properly handled. Large dies, forgings, gears, etc., should be heated slowly in order to prevent warpage and cracks. Contrary to popular belief, distortion usually occurs from rapid heating rather than in the quench. Operating an electric furnace at low temperature results in serious overshooting if maximum input is applied. Low temperatures are generally used for drawing or nitriding where accuracy of temperature control is most important. Similar overshooting occurs in pot furnaces if the rate of heating exceeds the ability of the pot to absorb the heat. A further problem was one of holding down the public service company's demand charge during certain hours of the day. It was inconvenient and sometimes impossible to take the furnaces off the lines entirely. What was needed was a means of reducing the consumption at such times. The Research Department of the company finally developed the Lindberg control, which satisfactorily solved all these problems. A turn of the dial changes the rate of heating to any percent of maximum required. In addition, when the maximum rate is required on heating, and a lower input required when the furnace reaches control temperature, this cycle can be obtained automatically.

MANUFACTURERS' LITERATURE

Note: (This department is conducted for the convenience of the readers of METALS & ALLOYS desiring to add to their files copies of current literature issued by manufacturers. Any items desired can be secured free by applying direct to the issuing firms or in those cases where a number of items are wanted applications may be sent direct to this office. A coupon is provided on which the numbers of the items required can be listed.)

New Indicating Pyrometer

Leaflet describes a new self-contained pyrometer with the thermocouple extending directly from the indicator to point of temperature measurement. Two standard ranges are available, 60°-800°F. and 60°-1600°F. Russell Electric Company, Chicago, Ill. (189)

Mercury Switch Indicating Temperature Controller

Catalog 6702 illustrates and completely describes the new line of Brown indicating controllers for temperature, pressure and liquid level. Brown Instrument Company, Philadelphia, Pa. (190)

Illinois Shape Book

The Third Edition of the Shape Book contains profiles of Sections, rolled on the Structural, Plate, Bar, Rail and other mills of Illinois Steel Company, together with tables and data. 278 pages, handsomely bound in leather. A.I.A. File No. 13-b. Illinois Steel Company, Chicago, Illinois. (191)

Chromalox

This catalog has been planned and arranged to help you find instantly the detailed information you want when you apply heat electrically. Curves for calculating heat requirements, heat absorption calculator, heats of fusion, melting points, weights, etc., installation diagrams, installation suggestions, wiring diagrams. 55 pages. Edwin L. Wiegand Co., Pittsburgh, Pa. (192)

"Simplified Arc Welding"

Booklet in which are briefly outlined a few of the modern applications of Electric Arc Welding in many industries—with a catalog section showing the latest developments in Arc Welding Equipment. 37 pages. The Hobart Brothers Co., Box EW-41, Troy, Ohio. (193)

Jeffrey Foundry Equipment

Catalog No. 540 completely describes and illustrates how various types of foundries have been modernized by the installation of Jeffrey Foundry Machinery. Typical arrangements of equipments are clearly pictured by perspective drawings. 44 pages. The Jeffrey Manufacturing Company, Columbus, Ohio. (194)

Aluminum

Attractive booklet describing and illustrating new applications of Alcoa Aluminum in the electric railway field. 29 pages. Aluminum Company of America, 230 Park Avenue, New York, N. Y. (195)

(Published by the same firm. Alcoa Aluminum and its Alloys. Booklet presenting in concise form some of the fundamental information concerning the alloys which are produced by Aluminum Company of America.)

Weld It Well!

Bulletin No. HW-3 illustrates and describes the P & H "Hansen" Welder. Contains also condensed specifications, cross section illustrating the inside story of an efficient arc welder, radiographs, applications. 23 pages. Harnischfeger Corporation, Milwaukee, Wis. (196)

Research on the Corrosion Resistance of Copper Steel

Treatise by D. M. Buck and J. O. Handy on this subject, illustrated. Contains much helpful and valuable information. Fourth Edition. 22 pages. Published by American Sheet and Tin Plate Company, Pittsburgh, Pa. (197)

Meltomat—the Modern Automatic Melting Machine

Booklet describing Meltomat, the modern automatic machine for the melting and conversion of non-ferrous metals. Illustration showing how Meltomat operates. United Furnace Engineering Co., Inc., 90 West St., New York, N. Y. (198)

Contour Measuring Projector

Booklet illustrating and describing the Contour Measuring Projector, an optical instrument for the precise measurement and inspection of small parts. 37 pages. Bauch & Lomb Optical Co., Rochester, N. Y. (199)

Automatic Temperature Control Pyrometers

Bulletin No. 182. The Wilson-Maeulen Pyrometer Division of the Foxboro Company introduces in this catalog new and improved models of Wilson-Maeulen Potentiometer Control Pyrometers. Data sheet for automatic control proposals, electric furnace data, fuel furnace data. This automatic temperature control equipment for regulating industrial application of oil, gas and electric heat is fully described and illustrated. 16 pages. The Foxboro Company, Foxboro, Mass. (200)

Operating Manual for Plating with CAD-A-LOY

Bulletin containing information covering all phases of CAD-A-LOY plating; preparing the material for plating, making up the solution, operation, analyzing the solution, testing the deposit, and other details. 23 pages. E. I. du Pont de Nemours & Co., Inc., The R & H Chemicals Department, Wilmington, Delaware. (201)

The Hump Method for Heat Treatment of Steel

Catalog No. 90 contains principles and practices, ideal conditions for correct hardening, the Hump Method, Automatic Control of Rate of Heating, Hump Method advantages, comparative record of results, applications, blanking dies and cutting tools, dies and molds, drop forge and die casting dies, stamping dies, production hardening, prices, etc. 40 pages. Leeds & Northrup Co., Philadelphia, Pa. (202)

TAG Magnetic Clutch Flow Instruments

Bulletin No. 1065 completely illustrates and describes these instruments. Charts, cross sections, flow specifications, instrument specifications, etc. 19 pages. C. J. Tagliabue Mfg. Co., Park and Nostrand Avenues, Brooklyn, N. Y. (203)

ENDURO

Booklet giving complete information about Enduro HCN, one of Republic's Perfected Stainless Alloys, developed to meet the severe requirements exacted by high temperature usage, Enduro NC-3, an austenitic alloy developed to meet the requirements of industry for still higher strength and oxidation resistance at higher temperatures, Enduro HC, a low carbon, high chromium alloy recommended for high temperature applications. Instructions for working, physical properties, applications are given. 8 pages. Republic Steel Corporation, Central Alloy Division, Massillon, Ohio. (204)

High Test Cast Iron and Alloy Iron and Steel Melting in Detroit Rocking Electric Furnaces

Paper presented before the annual Industrial Electric Heating Conference, National Electric Light Association at Detroit, Michigan, by A. E. Rhoads, Vice-President, Detroit Electric Furnace Co., setting forth attitude in the industry towards cast iron as an engineering material, foundry and production view points, application of Detroit Rocking Electric Furnaces, advantages of this type furnace in melting and superheating, typical installations, results produced. Illustrated. 29 pages. Detroit Electric Furnace Co., Detroit, Mich. (205)

Modern Industrial Furnaces

Attractive booklet containing valuable data on research, development, engineering, intangible factors upon which Surface Combustion builds successful furnaces for industry. Profusely illustrated. 27 pages. Surface Combustion Corp., Toledo, Ohio. (206)

Heat Treatment of Steels with Cyanides and Salts

Booklet (6th Edition) on this subject containing data on case-hardening, nitriding, reheating and mottling of steels with R & H Sodium Cyanide. Coloring, tempering, drawing and annealing of steels with R & H Heat Treating Salts. Dimensions and details of construction, tables of comparison, graphs, specifications, etc. 80 pages. The Roessler & Hasslacher Chemical Company, Empire State Building, New York, N. Y. (207)

Leitz Micro-Metallograph "MM"

Catalog No. 1057 (2nd Edition) illustrates and describes the Leitz Micro-Metallograph for use in the metal industries for examining the sand in the foundry, to determine the crystalline structure of metals as they pass through the different processes of manufacture, to check the finished product in regard to its surface qualities, contours and correct size. Tables. 44 pages. E. Leitz, Inc., 60 East 10th Street, New York, N. Y. (208)

(Published by the same firm. Catalog No. 1114 Leitz "Metallurscope" Inverted Metal-Microscope of small design, with camera. Model "MC," Catalog No. 1089, Leitz Metallographic Microscopes for routine work, Accessories and Photo-Micrographic Apparatus, Catalog No. 1090, Complete List of Micro-Objectives for metal examination and Micro-Oculars with magnification tables, both for visual observation and photomicrographic work. Catalog No. 1092, Treatise on Grinding, Polishing and Etching of Metallographic Specimens. Catalog No. 1093, Leitz Grinding and Polishing Machines for the preparation of metallographic specimens. Catalog No. 1094, Guthrie's Research Equipment for Grinding and Polishing Metallographic Specimens, with automatic [magnetic] Specimen Holder.)

Hytempite in the Foundry

Booklet containing data on Hytempite for refractory linings. Illustrations, tables of quantities and application, etc. 12 pages. Quigley Furnace Specialties Co., 56 West 45th Street, New York, N. Y. (209)

The Use of Nickel in Non-Ferrous Castings

Attractive 16 page booklet on this subject containing much useful and valuable data. Tables, illustrations. International Nickel Company, Inc., 67 Wall Street, New York, N. Y. (210)

(Published by the same firm. Electrolytic Nickel for Alloying Purposes.)

Grinding and Heat Treatment

Booklet on Grinding and Heat Treatment as Causes of Cracks in Hardened Steels, by C. E. Sweetser, Norton Research Laboratories. Tables. Illustrations. Norton Company, Worcester, Mass. (211)

Eagle "66" Insulating Cement

Attractive booklet containing data on Eagle "66" Insulating Cement for greater heat-saving efficiency. Illustrations, charts, tables, etc. The Eagle-Picher Lead Company, Cincinnati, Ohio. (212)

Radiography as a Tool in the Metal Industry

Interesting and valuable data is brought together in this booklet by W. L. Fink and R. S. Archer on this subject. Illustrated with radiographs, typical methods of blocking, diagrams, etc. Victor X-Ray Corporation, 2012 Jackson Blvd., Chicago, Ill. (213)

Union Special Carburizing Steel

Interesting booklet on this subject, containing illustrations, tables of analyses of test bars, tables of tensile properties, Brinell hardness, bend tests, impact tests, crushing tests, Rockwell hardness, etc. Union Drawn Steel Co., Beaver Falls, Pa. (214)

Erie Board Drop Hammers

Bulletin No. 240 contains full information on Type "F" and Type "A" Belt Driven Erie Board Drop Hammers. Illustrations, instructions for erection and maintenance, material specifications, standard dimensions, diagrams, parts reference list. Erie Foundry Company, Erie, Pa. (215)

Misco Chain

Bulletin No. 1 illustrates and describes Misco Chain for use at high temperature. Illustrated. The Michigan Steel Casting Co., Detroit, Mich. (216)

The Baldwin-Southwark Corporation

A brief outline of the histories, purposes and products of the major companies which have been combined to form this new industrial unit. Illustrated. 16 pages. Philadelphia, Pa. (217)

Hayes "Certain Curtain" Electric Furnaces

A series of bulletins illustrates and describes these products as follows: Bulletin No. 10, The Hayes "Certain Curtain" Atmosphere Control; Bulletin No. 20, "Effects of Atmosphere Control in Precision Hardening"; Bulletin No. 101, "Type 'HG' for hardening alloy and high speed steels; range 1850° to 2500°F."; Bulletin No. 201, "Type 'LR' for production heat treating up to 1850°F." C. I. Hayes, Inc., 129 Baker Street, Providence, R. I. (218)

Smith-Taber Model "E" Precision Stiffness Tester

Bulletin E-10133 gives a technical description of this tester including illustrations of operation of Model "E" Precision Tester, also stiffness and elastic properties of materials charted from results obtained with the Smith-Taber Stiffness Tester. Smith-Taber, Research Engineers, North Tonawanda, N. Y. (219)

METALS & ALLOYS, 330 West 42nd St., New York, N. Y.

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